# INDUSTRY AND POWER

*Featuring:*


*Applications of Steam Accumulators in Process Plants* ..... Page 69
*Fundamental Principles of Automatic Control* ..... Page 77
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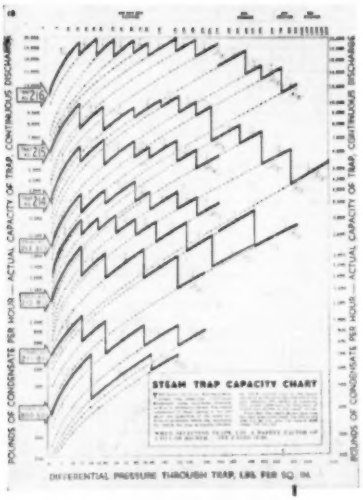
# Only actual hot condensate capacities give a true picture of steam trap value

*YOU KNOW THE CAPACITY WHEN YOU BUY AN ARMSTRONG*


STEAM TRAP CAPACITY CHART
POUNDS OF CONDENSATE PER HOUR — ACTUAL CAPACITY OF TRAP CONTINUOUS DISCHARGE
DIFFERENTIAL PRESSURE THROUGH TRAP, LBS. PER SQ. IN.

***IT PAYS TO KNOW BEFORE YOU BUY!***

**THE ARMSTRONG STEAM TRAP CAPACITY CHART is based on hundreds of tests with hot condensate. You can depend on its accuracy.**

**SEE OUR CATALOG IN SWEETS OR CEC**

THEORETICAL calculations fail entirely to give a true picture of trap capacity. Orifice tests fail to account for capacity losses caused by pipe friction. Tests with cold or warm water do not take into consideration the capacity-reducing effect of flash steam. Only tests with actual trap hookups handling hot condensate will tell you the true continuous discharge capacity of a steam trap—and those are the capacities Armstrong gives you.

If capacities are misleading you may buy a trap too small for the job. Or, if you compare different makes of traps on a price basis you must know if they are comparable on a capacity basis or the comparison means nothing.

*Dollar for dollar and size for size Armstrong steam traps give you greater capacity*—another reason why they are your wisest buy. Your nearby Armstrong Representative can supply you. Call him for recommendations.

**ARMSTRONG MACHINE WORKS**
**820 Maple Street • Three Rivers, Michigan**

**The 36-PAGE STEAM TRAP BOOK gives Armstrong trap capacities and tells how to select the right size trap for every job. Ask for a copy.**

# ARMSTRONG STEAM TRAPS

# Here is *Exactly WHY* a V-Belt with CONCAVE SIDES Gives You *Longer Wear!*

To see for yourself how a V-Belt that has *concave sides* is certain to give longer wear, just make this simple test:—

**Pick up any V-Belt you have at hand. Bend that belt as it bends around a pulley. As it bends, grip its sides between your fingers. Here is what will happen *everytime*.**

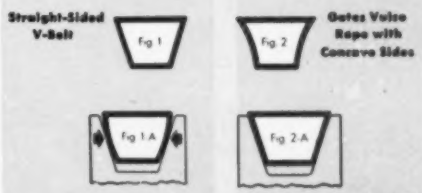
If the V-Belt you are testing has *straight sides*, you can feel those sides *bulge out* as the belt bends. This out-bulge forces the sides of the belt to press *unevenly* against the V-Pulley and you naturally get *concentrated* wear just where the bulge is greatest—as shown in figure 1-A, at right.

**Now, make this same test with the belt that is built with Concave Sides—the Gates Vulco Rope!**

Whereas you felt an *out-bulge* when you bent a belt with straight sides, you find that the *Concave Sides* merely fill out and become *perfectly straight*. The sides therefore *press evenly* against the V-Pulley. This distributes the wear *uniformly* across the *full width* of the belt. Naturally, this means longer belt life and *lower* belt *costs* for you!

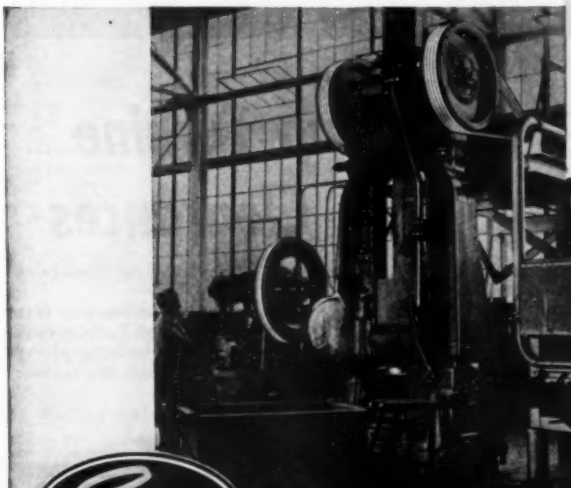
**Only V-Belts made by Gates are built with concave sides. Whenever you buy V-Belts, be sure that you get the V-Belt with the Concave Sides—The Gates Vulco Rope!**

**What Happens When a V-Belt Bends**




How Straight-Sided V-Belt Bulges in Sheave-Groove. Sides Press Unevenly Against V-Pulley Causing Extra Wear At Point Shown by Arrows.

The Concave Sides Fill Out to a Precise Fit in the Sheave Groove. No Side Bulge! Sides Press Evenly Against the V-Pulley — Uniform Wear — Longer Life!



This drop hammer in the plant of Kortick Manufacturing Company of San Francisco is operated by the Gates Vulco Rope Drives shown. Mr. W. H. Reiman, Plant Supt., says: "...a great improvement in the speed of the return stroke...gives us a positive drive without slip, yet one that absorbs the shock of picking up the ram repeatedly."

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Hose V-Belts
Molded Rubber Goods
for Industry

VULCO ROPE DRIVES
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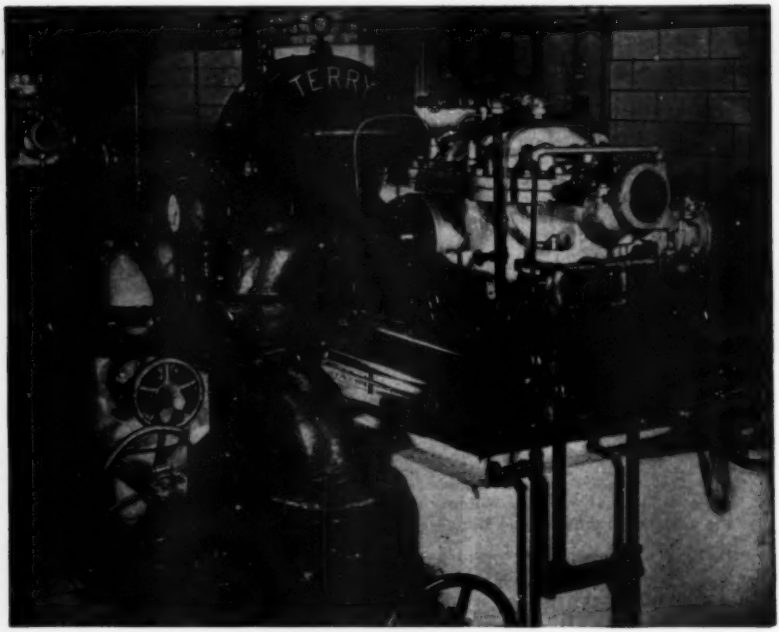
# TERRY




## 110hp Feed Pump Turbine with Large Safe Clearances

The blades of this turbine are milled out of a one-piece forged-steel wheel with generous clearance both radially and axially. The side clearance is very large — one inch — and the blades are protected by a projecting rim on each side of the wheel. It is therefore impossible for the blades to foul and end play can do no damage to the turbine.

These are but a few of the features that make the Terry Solid-Wheel Turbine such a dependable driver. A bulletin giving other interesting facts about this turbine will be sent upon request.

T 1179

**THE TERRY STEAM TURBINE COMPANY**
**TERRY SQUARE, HARTFORD, CONN.**

Edited specifically for executives and engineers responsible for the selection, installation, operation & maintenance of equipment required for Engineered Plant Services*

# INDUSTRY AND POWER

*The Magazine for Engineered Plant Services*


VOLUME 61 **SEPTEMBER, 1951** NUMBER 3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**INDUSTRY AND POWER**

OFFICE: 420 MAIN STREET
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Established May, 1920

Member Controlled Circulation Audit and National Business Publications, Inc.



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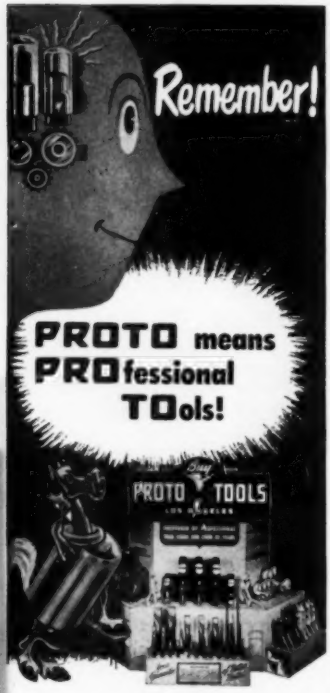
INDUSTRY and POWER, including INDUSTRIAL POWER, is published monthly at St. Joseph, Michigan. Accepted under the act of June 5, 1934, authorized August 31, 1942.


***Engineered Plant Services**

By ***Engineered Plant Services*** we mean the ***providing*** or ***generating, transmitting, controlling, applying,*** and ***maintaining*** of POWER, STEAM, MECHANICAL DRIVES, HEAT, ELECTRICITY, AIR, WATER, and other engineered services in and for all areas of the industrial establishment as required for production and operation. This includes Lubrication, Piping Systems, Industrial Waste Disposal, Corrosion Control, Electrical Systems, Industrial Heat, Coal and Bulk Handling, Dust and Fume Control, and other related services of an engineering nature.




That Power Sockorse pose is a reminder to remember that PROTO signifies highest professional standards. PROTO tools are light but strong, balanced, easy handling, snug fitting. They're properly forged from special steels and scientifically heat treated to impart extra strength, toughness and life! Buy PROTO tools from your dealer's big selection, while still obtainable. Send 10¢ for 68-page catalog to

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# Acorns of science

***Developments not yet available, but of interest to those who are responsible for Engineered Plant Services***

### Base for Chrome Plate

● With nickel restricted by the government, Du Pont engineers are working with a white brass alloy to provide a suitable base for chrome plate. It is an 80/20 zinc-copper alloy electrodeposited from a cyanide bath using special brightening agents. Application to plating was discovered several years ago. In the present emergency, the company is working to overcome a number of technical obstacles. All information has been made available to industry, which is also conducting large scale tests.

### Liquid Metal Pumps

● A recently issued patent, No. 2,558,-698, describes a liquid metal pump of increased efficiency operating on the electromagnetic principle. A series of insulating barrier vanes inside the liquid metal conduit reduces tendency of current to diverge in passing through the liquid metal. This apparently applies principle that electromagnetic force intensity increases with square of current density.

### For Fire Only

● A fire warning device not affected by overheat or bright sunlight has been developed by the Equipment Laboratory at Wright-Patterson AFB. Amplified output of lead sulphide cell sensitive to infrared radiation reacts to flicker, or varying intensity of flame. The unit can detect a gasoline flame in a $2\frac{1}{2}$ in. container at 10 ft.

### More Peacetime Radioactivity

● First application of radioactive thickness gages to the tire industry may also mean smoother running and longer wearing rubber belts. The General Tire and Rubber Co. has a beta ray gage using two small grains of strontium 90 from the atomic pile at Oak Ridge. As in similar gages, rubberized fabric from the calender machine passes over the radioactive source and interrupts radiation in proportion to thickness. An ionization chamber measures transmitted radiation, interprets thickness with greatly increased accuracy.

### Faster Magnetic Amplifiers

● Based on new theory of magnetic amplifier operation, experiments with a parallel connected unit have resulted in considerably improved response. Output current reaches steady state conditions one half cycle after application or removal of control voltage. Good output power to weight ratio is obtained with the unit.

### Portable Liquid Gas Plant

● Scaled down from large commercial units to small size for shipboard use by the Engineering Experiment Station, the plant compresses, cools, liquifies and fractionates air into the major components, oxygen and nitrogen. The liquid oxygen is pure enough for breathing, the nitrogen for inerting gasoline lines. The object—to substitute the plants for heavy steel storage cylinders now used—indicates value of the plants on other applications for the liquids or gases.

### Electrical Faults

● Aircraft electrical faults investigated at the Naval Research Laboratories produced interesting results. On simulated 120/208 v, 400 c system, 5 per cent were welded faults (continuous metal to metal contact), 95 per cent were intermittent. With 120 v d-c, 91 per cent were of intermittent type.

# *You can be sure when a* **B&W Refractories Engineer** *recommends boiler refractories*

**If you are having trouble with boiler furnace linings . . . if they are causing high maintenance costs and excessive outages . . . consult your B&W Refractories representative. He understands your problems . . . knows their solutions . . . And he can make expert recommendations from B&W's *complete* line of refractories:**

### HEAVY FIREBRICK

For furnaces with slagging, flame impingement and spalling conditions, either B&W 80 or Junior Firebrick can be used. 80's assure uninterrupted service at extremely high ratings. Juniors are recommended where load bearing and temperature requirements are less severe, but too severe for the best grades of fireclay brick.

### INSULATING FIREBRICK

*B&W Insulating Firebrick* have the lightest weight and lowest heat conductivity of any insulating firebrick in their class. They store and conduct less heat—withstand direct exposure to furnace gases. Available in six types for temperatures from 1600 F to 2900 F.

### PLASTICS

Used widely for repairs and for forming special shapes *in place*, B&W *Plastic Moldable* and *B&W Plastic Chrome Ore* offer long life under severe conditions. Plastic Moldable is suitable for use in the great majority of furnaces. It withstands temperatures up to 3000 F. Plastic Chrome Ore is ideally suited for severe slagging conditions.

### CASTABLES

In furnaces that require the high resistance of chrome to chemical attack and where speed of installation is important, B&W offers *Kromecast* for temperatures up to 3100 F and *Hydrochrome* for temperatures up to 2800 F.

For burner openings, door linings, walls, roofs and arches, B&W *Kaocast* possesses unusual volume stability and resists spalling. It easily withstands temperatures up to 3000 F.

*B&W Baffle Mixes* are excellent castables for the construction of monolithic boiler baffles, door linings and other general uses. They are smooth and flow easily, have high strength in small sections. Widely used to withstand temperatures as high as 2600 F.

*B&W Insulating Concrete Mixes* combine refractoriness, light weight and low heat conductivity with the ability to be poured like ordinary concrete. For temperatures up to 2200 F.

### MORTARS

*B&W Mortars*—Selecting the right mortar is vitally important to long refractory life. B&W Mortars pay for themselves by saving time in application and by satisfactorily performing their jobs under the designed furnace conditions.

**For help with a furnace maintenance plan to cut costs and prevent unscheduled outages, call your local B & W Refractories Engineer.**

128-B

**B&W REFRACTORIES PRODUCTS**

B&W ALLMUL FIREBRICK • B&W 80 FIREBRICK
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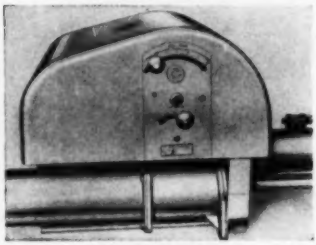
# New equipment and developments

***Here are the high lights of New Equipment and Development items announced by leading manufacturers, briefed for your convenience***

**See Readers Service Card Page 140**

## 1—STOKER AIR-FUEL RATIO CONTROLLED

Material increase in the overall combustion efficiency of Iron Fireman industrial stokers is claimed by that company through development of automatic linkage of the fuel and air supply, which keeps the air-fuel ratio in constant balance. Accurate metering of coal from bunker to boiler by



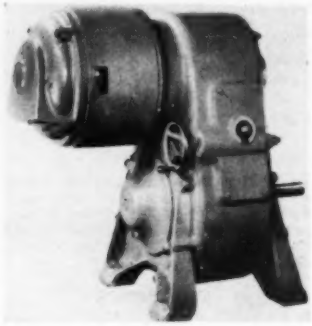
means of the worm conveyer is synchronized with the accurate metering of air from fan to boiler by the Iron Fireman Air Volumeter. Thus the correct air-fuel ratio is maintained regardless of varying load demands. Operating rate of the stoker is determined by the position of the upper quadrant in the control panel. This may be connected directly to the power operator of a modulating combustion control or operated manually as well. The control can be set for quick build-up of fire after cleaning. Changes in the air-fuel ratio are effected by manual adjustment of the "air ratio" quadrant.

## 2—CHAIN VISE EFFECTS SAVINGS

Disassembling, repairing or connecting roller chain is now simplified by the use of the Baldwin-Rex chain vise recently announced by Baldwin-Duckworth Div. of Chain Belt Co. The vise makes it possible to take apart single or multiple strand roller chain in a few minutes with ease, the manufacturer claims. The vise is made from forged steel for long wear, with hardened jaws specially shaped for adapting to various chain sizes. It is made in two sizes which together handle a range of chains from single strand, ½ in. pitch through double strand, 2 in. pitch. Use of this vise permits stocking long lengths of chain that can quickly be made up into required lengths without waste.

## 3—VARIABLE SPEED DRIVE FEATURES PROTECTION

Larger horsepower Speed-Trol electric motor drives have now been added by Sterling Electric Motors, Inc. They are designed to meet the growing demand for variable speed drives of 20 and 25 hp ratings. Fea-

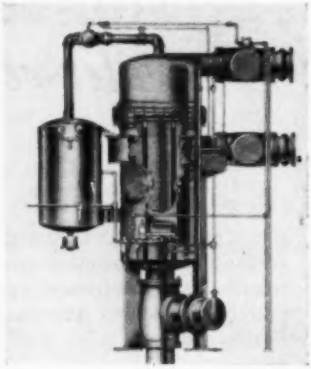


tures of this unit are positive adjustment of pulleys, infinite speed variation and accurate control of speed under varying loads.

The type KFE Speed-Trol is the first of a series in the range of 20 to 25 hp. According to Sterling's announcement, drives of these ratings will also be available in splash-proof and totally enclosed fan-cooled models, and with built-in reduction gears for the lower speed ranges. All models can be supplied with manual, electrical or mechanical remote control.

## 4—CLARIFIER CLEANS OWN FILTER SCREENS

A recently designed Houdaille Automatic Clarifier system, which removes abrasives and other solid contaminants from machine tool coolants, transports waste to a disposal point and cleans its own filtering screens in automatically timed cycles is announced by the Honan-Crane Corp. This equipment, which removes particles as small as five to ten microns, consists of a multiple-screen clarifier, blowdown tank with conveyer, and an automatic control panel. Contamination is automatically removed to a disposal point by built-in, tube-enclosed chain conveyer. The system is specifically designed for plant operations involving large numbers of machines served by a central coolant system, and may be



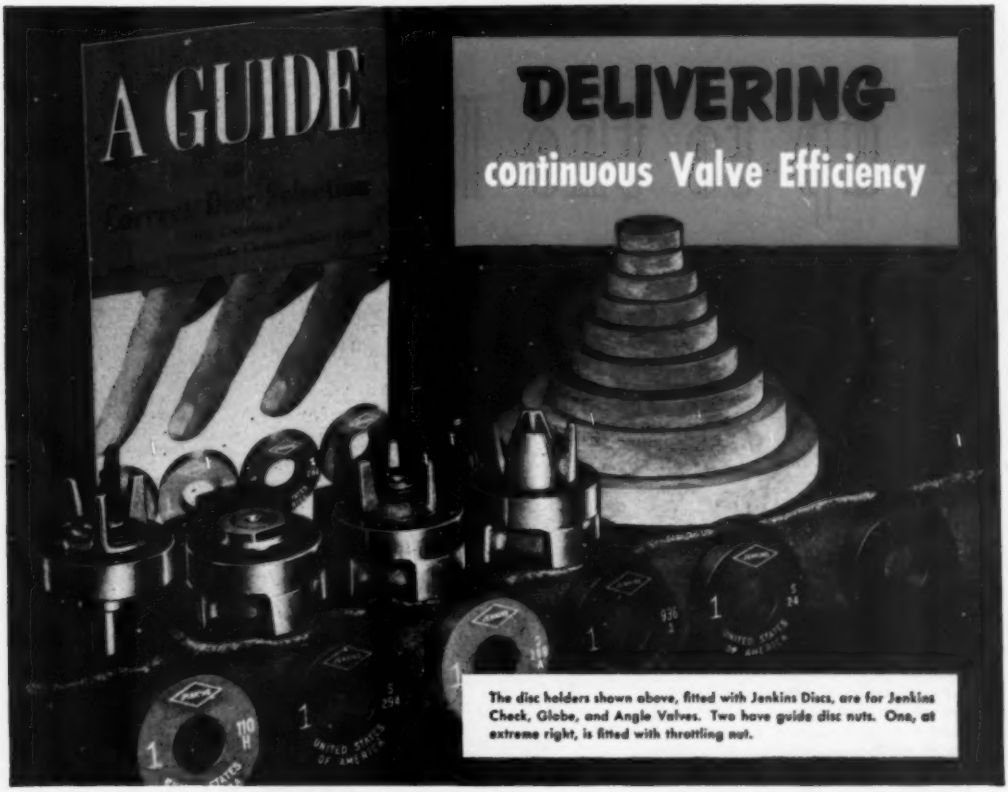
used for clarification of mineral oil or soluble oil coolants. While the systems are built to provide flow rates up to 1000 gpm, the installation of several units in a central system allows an unlimited volume of liquid to be handled.

## 5—ARC WELDER OFFERS FLEXIBILITY

The Model "88" industrial a-c arc welder designed by Miller Electric Mfg. Co. is especially adaptable for maintenance welding. With a welding current range of 20-300 amp, it operates on 220 v 50/60 cycle a-c lines, although dual operation voltage can be provided. Continuous, stepless current

control is provided through a crank on top of the welder. The current setting is shown on the indicator on the front of panel. Two quick-disconnect cable receptacles are provided for a choice of two open circuit voltages. The Model "88" carries full Un-

***( Continued on page 12 )***




The disc holders shown above, fitted with Jenkins Discs, are for Jenkins Check, Globe, and Angle Valves. Two have guide disc nuts. One, at extreme right, is fitted with throttling nut.

Now, when *continuous valve efficiency* is vital . . . you can rely on readily available Jenkins Renewable Composition Discs to provide the valve protection that greatly extends service life. Proper disc selection and replacement in time guard against premature wear, can multiply the original efficiency of valves many times over.

Disc replacement is simple and easy, can be done without removing valves from the line. To save more time, maintenance-wise valve users keep on hand a stock of disc holders fitted with the discs most commonly used.

**Only Jenkins makes *both* Valves and Discs**

Originator of the first successful Renewable Composition Disc, Jenkins Bros. has continued to set quality standards. That's why you can rely on your Jenkins Distributor for discs of time-tested design and composition, plus authoritative disc information.

Ask your Jenkins Distributor for the folder, "A Guide to Correct Disc Selection" . . . also the "Jenkins Disc Selector", a handy wall chart listing recommended discs for all common services, temperatures, and pressures. Or write Jenkins Bros., 100 Park Ave., New York 17. Jenkins Bros., Ltd., Montreal.

Money-saving idea
for disc-valve maintenance

**Keep on hand a stock of disc holders fitted with the discs most commonly used. This permits quick replacements, saves valuable time.**

Slip off the disc holder with the old disc, and slip on another containing the new disc.
When you have time, reload the old disc holder with a new disc.

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VALVES
SINCE 1864
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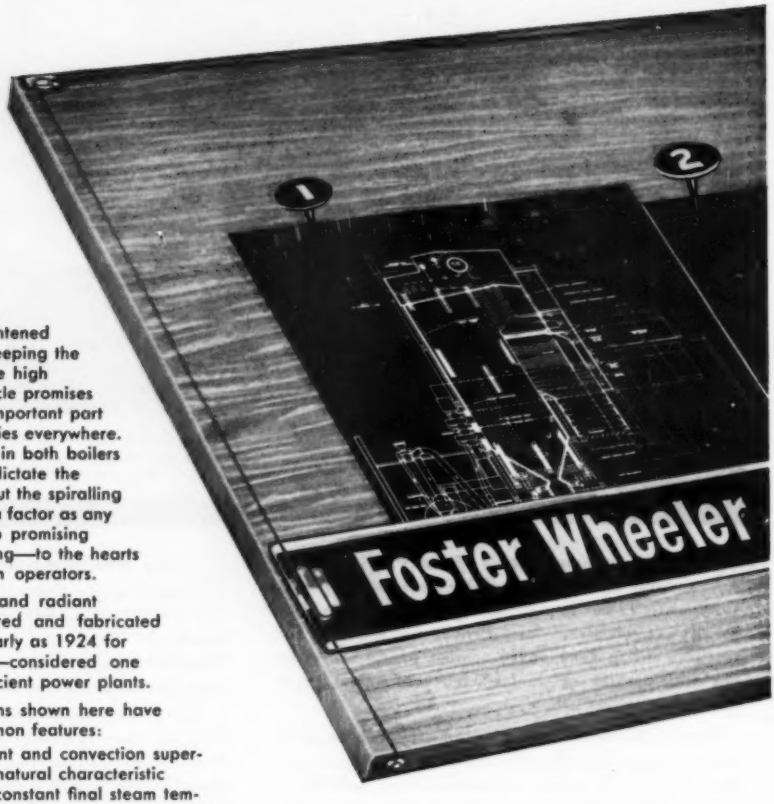
# . . . up to the largest




A new wave of enlightened interest in Reheat is sweeping the country as the role of the high pressure, high steam cycle promises to play an increasingly important part in power-generating facilities everywhere. Today, design developments in both boilers and turbines frequently dictate the use of the Reheat Cycle. But the spiralling cost of fuels is as much a factor as any in endearing this tool—so promising from its very beginning—to the hearts of steam-electric station operators.

Radiant superheaters and radiant reheaters were engineered and fabricated by Foster Wheeler as early as 1924 for one midwest station—considered one of the country's most efficient power plants.

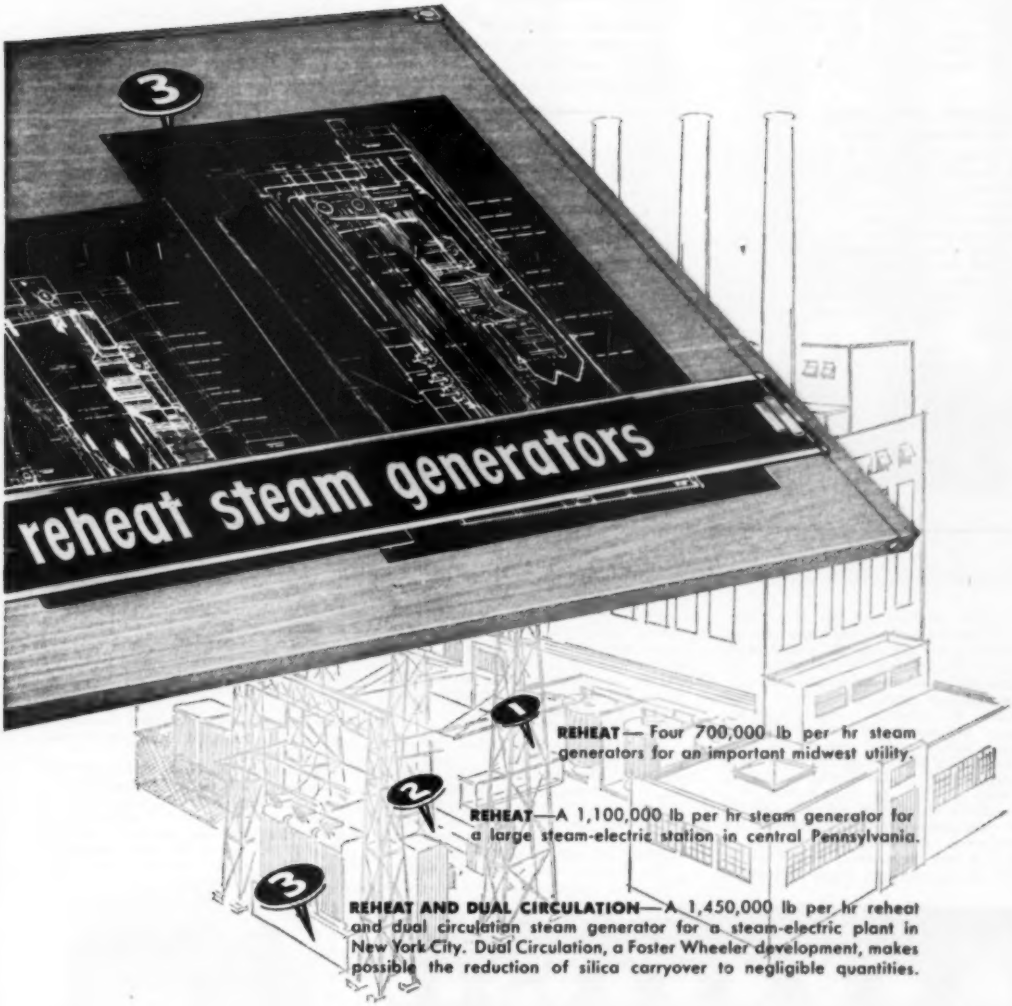
The Foster Wheeler designs shown here have the following common features:

**(a)** Combination radiant and convection superheaters have a natural characteristic maintaining a constant final steam temperature over a wide load range with a minimum amount of control equipment.

**(b)** Since superheating is done partly in the radiant superheater a two-fold purpose is served. Gas temperature leaving the furnace can be reduced and danger of slagging is thus obviated.

**(c)** Steam generator characteristics are integrated with those of the turbine.

***For further information, write to:*** **FOSTER WHEELER**




**REHEAT**— Four 700,000 lb per hr steam generators for an important midwest utility.

**REHEAT**—A 1,100,000 lb per hr steam generator for a large steam-electric station in central Pennsylvania.

**REHEAT AND DUAL CIRCULATION**—A 1,450,000 lb per hr reheat and dual circulation steam generator for a steam-electric plant in New York City. Dual Circulation, a Foster Wheeler development, makes possible the reduction of silica carryover to negligible quantities.

CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER

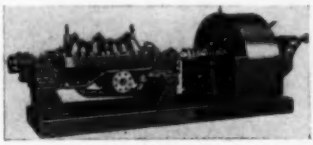
# New equipment and developments

*( Continued from page 8 )*

derwriters' Laboratory approval, and comes equipped with regular accessories. It normally comes equipped with four casters, a three wheeled pivoted truck with towing handle being available at extra cost.

## 6—PUMPS APPLICABLE FOR MANY USES

Opposed impeller 4-6-8 stage pumps being manufactured by the DeLaval Steam Turbine Co. as their "Oppeller" pumps are designed for general medium pressure and temperature service up to approximately 1000 gpm and 1200 psi for temperatures to 350-400F. They are especially well suited to boiler feed service, oil refinery services for handling liquids ranging from propane to strong caustic and general water services such as descaling, hydraulic and mine drainage.

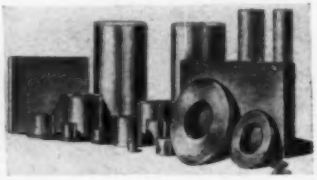


This pump has a horizontally split casing with suction and discharge nozzles on opposite sides of the lower half of the casing. Impellers are mounted back to back to balance axial thrust and the volutes are staggered 180 deg to balance radial thrust. Being bolted in, stuffing boxes for specific pump applications and various seal arrangements can be applied.

**Additional information on new equipment and development items is available. Use card inserted between pages 140 & 141**

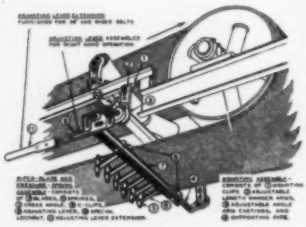
## 8—BEARING STOCK SIZES INCREASED

Boston Gear Works has added 157 stock sizes of Bost-Bronz oil impregnated porous bronze bearings to meet the demand for a comprehensive range of stock sizes in cylindrical bearings, thrust bearings, cored and solid bar and plate stock. Interchangeable with solid bronze bearings, in daily use with all types of loads and speeds, they are claimed to offer a number of important performance advantages. Having an oil film to start on as well as run on they operate quietly and give long service. There is no oil drip. Oil holes or grooves are eliminated, and the complete range of sizes permits simple press fits.



## 9—CONVEYER BELT CLEANER USES SPRING PRESSURE

A spring type conveyer belt cleaner currently produced by Stephens-Adamson Mfg. Co. is claimed by the maker to be one of the most effective methods yet devised for



cleaning conveyer belts. Self aligning, spring steel wiper blades, set perpendicular to the belt surface but diagonal to belt travel, wipe the belt clean and dry as it passes. Spring arms supporting the blades maintain a uniform pressure on the belt and allow blades

*( Continued on page 15 )*

## 7—CONTROL UNITS CONSERVE SPACE AND REDUCE OPERATIONAL TIME

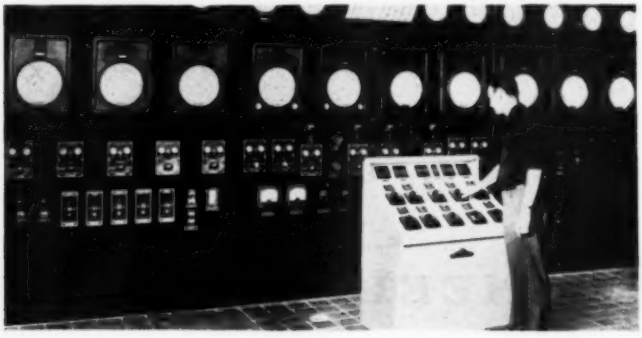
Control panels that offer lower operating expense and reduced space requirements in power and industrial process plants are now available from the Bailey Meter Co. Miniature indicators and control units concentrated into small space give a single operator the information and controls necessary to operate boilers, turbines, or process units — such as cement mills, foundries, fuming plants, pulp and paper mills, chemical plants and refineries.

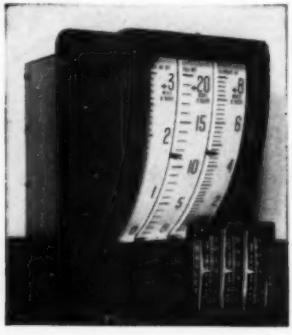
Space savings are considerable. For example a multi-point indicator uses 87 per cent less space than its standard size counterpart. A selector valve occupies 52 per cent less space, and a remote manual relay 70 per cent less space. The instruments will be mounted on console type centralized control panels whenever possible. These panels will be more than 50 per cent smaller than any previously available. Control may be entirely automatic or manual — with individual units or the entire system controlled manually from relays at the operators finger tips.

The indicator is made up of individual vertical scale units nested together in whatever quantities necessary for comparing a set of related factors. When two factors with common scales are being measured their values can be indicated on a single vertical scale with separate pointers, thus doubling the capacity of each unit.

The selector valve can be employed for either remote manual or automatic operation of air-operated controls. In this instrument there is no reset position for transferring between remote manual and automatic control, and changes can be made instantaneously without causing any disturbance to the control factor. Two vertical scale units have been mounted in the face plate of the selector valve to provide easily-read information for all operations.

For factors that do not warrant automatic control but need only occasional manual adjustment the remote manual relay is available. It is similar in appearance to the selector valve but smaller in size and saves 72 per cent of the panel board space required for standard remote manual relays.





# FILMING AMINES

## Prevent Return Line Corrosion

*Send for Betz Technical Paper #121, "How Filming Amines Prevent Steam and Return Line Corrosion."*

***CORROSION** of steam and condensate return lines is a serious problem to most industrial plants.* Such corrosion is caused by the presence of carbon dioxide and oxygen. Up to now, it has been the usual practice to neutralize the carbon dioxide. However, the high cost of this neutralization method has limited its application. And, no protection against oxygen corrosion is assured.

Betz Laboratories have developed a new advanced process for the prevention of return line corrosion employing *octadecylamine.* This material *does not* neutralize the carbon dioxide. Instead, the amine is adsorbed on the metal surface in a monomolecular non-wettable film which acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. The monomolecular film does not increase in thickness with continued treatment.

Results? As high as 99 per cent reduction in corrosion rate has been achieved. Maintenance and replacement costs on return line systems have been reduced to negligible amounts.

Let a Betz Field Engineer show how you can cut costs in your plant with the use of filming amines. Write today! There's no obligation of course. W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories, Limited, Montreal 1.

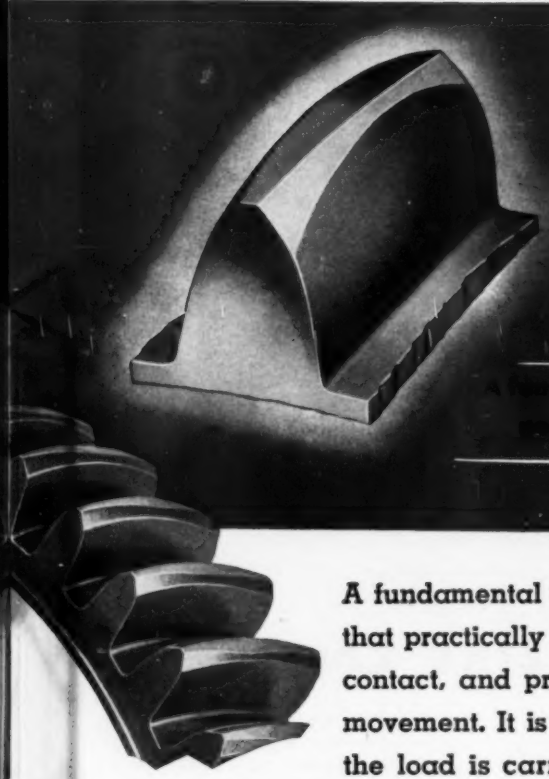
*U. S. PATENT 2,460,259
CANADIAN PATENT 461,238

**BETZ**

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

# THE AMERIGEAR* FULLY CROWNED TOOTH

*Trade Mark Registered



## A MAJOR IMPROVEMENT IN GEARING

A fundamental improvement in gear tooth design that practically eliminates all "end tooth and tip" contact, and provides greater freedom of axial movement. It is the first gear tooth on which all the load is carried on strong flanks rather than tooth edges. It reduces backlash to a minimum and permits greater load-speed capacity. The result of a program of continuous research and development, keyed to achieve higher efficiency in the transmission of power, the *Amerigear Fully Crowned Tooth* may be utilized in solving a wide range of special power transmission problems other than those common to gear-type couplings in which it is now incorporated. A folder on the Amerigear Fully Crowned Tooth is available on request.

**AMERICAN FLEXIBLE COUPLING COMPANY**

*Originator of the Amerigear Fully Crowned Tooth • Sales Offices in Principal Industrial Centers*

**ERIE, PA., U. S. A.**

*AFFILIATE OF J. A. ZURN MFG. CO. • ERIE, PA., U.S.A.*

# New equipment and developments

*( Continued from page 12 )*

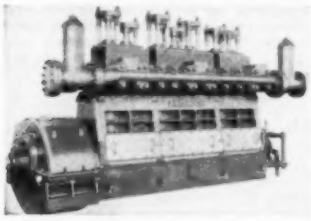
to ride easily over obstructions such as belt splices. Dribble from the cleaner falls directly into the rear of the discharge chute at the head end of the conveyer.

Since the wiper has an independent mounting assembly, it can be easily adapted to fit existing conveyer installations. Adjustments and replacements can be made from either side without interrupting operations.

**Additional information on new equipment and development items is available. Use card inserted between pages 140 & 141**

## 10—DIRECT FLOW PUMPS HAVE SIX INCH STROKE

The Aldrich Pump Co. announces the addition to their line of a six inch stroke direct flow pump series, which includes Triplex, Quintuplex, Septuplex and Nonuplex units having 3, 5, 7 and 9 plungers respectively. Ranging from 300 to 900 hp, this series covers numerous applications such



as chemical handling, heavy forging press service, steel mill descaling, water injection in oil fields and lean oil pumping.

These direct flow pumps, featuring inverted design, operate at crankshaft speeds up to 300 rpm and are suitable for direct drive by engine or synchronous engine-type motor. All wearing parts are interchangeable. The direct flow fluid-end is sectionalized in construction for easy maintenance. Reduced space between valves affords higher volumetric efficiency, and changes in plunger size can readily be made to meet alterations in pressure or capacity.

## 11—TRANSFORMER USED INDOOR AND OUTDOOR

The butyl-molding process has now been applied to a line of current transformers, the first developed for both indoor and outdoor application. Announced by the Meter and Instrument Dept. of the General Electric Co., the line of 600 v transformers can be used on single-phase and on polyphase circuits. The butyl insulation combines low moisture absorption, good corona and sunlight resistance, excellent ad-

*( Continued on page 16 )*


**STOP** COSTLY SHUTDOWNS DUE TO COUPLING FAILURE

***THE PROVEN GEAR-TYPE COUPLING WITH FULLY CROWNED TEETH***

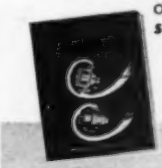
**Teeth designed and formed to accomplish tight fit on the crown, as well as on the flanks. Teeth that reduce backlash to a minimum and operate with relatively constant stresses on all teeth simultaneously in all positions; provide freer axial movement; prevent end tooth and tip contacts; assure quiet performance; enlarge load and speed capacity, and give so much more protection than ever before against downtime. These advantages, plus thrust compensation, and correction for angular and lateral misalignments give relief from coupling failure grief. Amerigear Couplings are available for all standard shaft sizes and the widest range of speed and load capacities. Catalog available on request.**

**AMERICAN FLEXIBLE COUPLING COMPANY**

*Originator of the Amerigear Fully Crowned Tooth*
*Sales Offices in Principal Industrial Centers*

**ERIE, PA., U. S. A.**

*AFFILIATE OF J. A. ZURN MFG. CO.*



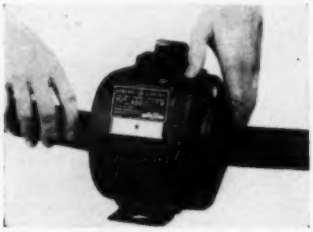
***Manufacturers of the original "Oldham Type" American Flexible Coupling.***

AMERICAN FLEXIBLE COUPLING CO., ERIE, PA., U. S. A.
Please send me further information regarding AMERIGEAR COUPLINGS with the Fully Crowned Teeth and Catalog No. 501.

Name ..... Title .....
Company .....
Address .....
City ..... State .....
Please attach to your business letterhead. Dept. 11

# New equipment and developments

*( Continued from page 15 )*

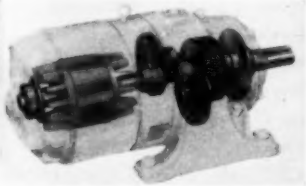


hesion to copper, very low power factor and good resistance to mechanical damage.

The transformers can be mounted indoors in any position on any flat surface. When used outdoors, the butyl-molded transformers can be installed on poles, without cross arms or enclosing boxes. First of the new line is Type JKP-O, a 600-v window-type current transformer with primary ratings of 200, 400 and 600 amp. It is designed to carry 200 per cent of rated primary current continuously. When mounted on an adapter plate, the new transformer meets dimensional requirements of EEI specification MS2 for low-voltage metering current transformers.

## 12—GEARED MOTOR UPS TORQUE RATING

A new principle in geared motors has been developed by U. S. Electrical Motors in their Type GL Syncrogear. By using two secondary pinions to drive the output gear, engineers have doubled the effective torque rating of a conventional single pinion and gear unit. Incorporating the use of a splined herringbone pinion to equally divide the

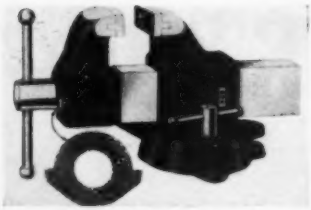


load between the two secondary pinions, the unit produces high torque at low speeds while occupying only a fraction of space required of a conventional drive.

Available with ratings of 5 to 25 hp and with speeds from 30 to 84 rpm, the unit has features of asbestos-protected windings, normalized castings, solid Centricast rotors and Lubriflush lubrication.

## 13—MACHINISTS' VISE OPERATES EASIER

An improved line of malleable iron machinists' vises is announced by the Columbian Vise & Mfg. Co. An outstanding feature is use of a new type graphite-bronze, self-lubricating thrust bearing located at the front of the sliding jaw to absorb



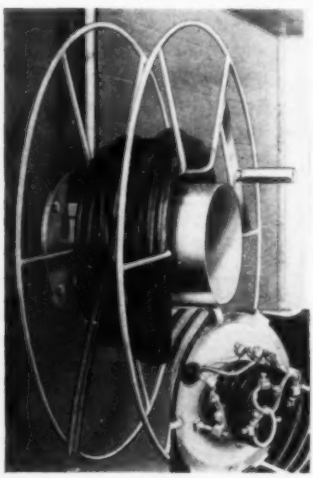
thrust of the steel screw head, provide easy and positive operation, prevent wear and eliminate end play. The manufacturer states that, because of this bearing, the vises can be pulled up tighter and held more securely with less pressure. Another feature consists of steel ball handle ends that are forged from the handle stock.

Columbian machinists' vises are made in standard sizes from 3 to 8 in. jaw widths. Their malleable iron castings are guaranteed unbreakable. Hardened tool steel jaw faces of "T" section design are pinned into the castings so they cannot come loose but can be easily replaced.

**Additional information on new equipment and development items is available. Use card inserted between pages 140 & 141**

## 14—CABLE REEL HAS WALL MOUNT

A compact wall-mounting Powereel that can be permanently mounted in or on trucks, walls and other places to make handling of heavy electrical cable easier and more efficient, is being manufactured by Industrial Electrical Works. The Powereel is said to offer the basic advantages of sav-



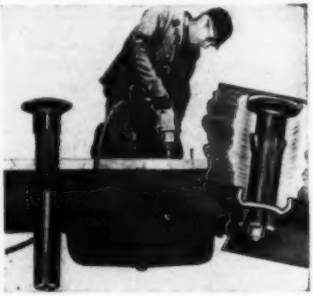
ing time and labor and reducing cable wear. Primarily developed to handle or transport cable having a stationary application, it has a special mounting flange on the side. This flange is threaded to fit a 1 in. iron conduit or afford a water-tight connection for flexible feeder cables.

A collector ring is standard so that no interruption of current is caused during winding or unwinding of the cable. The reel is available in any size with either a 75 amp collector ring for 2, 3 or 4 conductors, or a 30 amp ring for up to 16 conductors. Screw binding posts make attachment of cable an easy matter.

## 15—SLEEVE TYPE FASTENER ELIMINATES HELPER

A one-man expansion sleeve type fastener is announced by Square Tool & Die Co., Chicago Drillet Div. Primarily it eliminates the second man required in inserting and tightening conventional bolt and nut, as it has no nut.

Bolt is simply inserted in hole. A pneumatic tool drives bolt through sleeve and



expands six prongs at bottom of sleeve. This forms an extremely tight grip which cannot work loose due to vibration. The bolt head automatically countersinks itself below wood surface. The fastener is made in sizes from ¼ to 1 in. dia.; lengths from 1 in. up; and with various head styles.

## 16—LINK BELTING CAN BE REVERSED

Leather link construction, double faced "V" belting manufactured by Graton & Knight Co. is claimed to have the high power transmission capacity of leather. It has great efficiency on small pulley, short center drives.

Each link consists of two fibre sections faced with oak tanned leather. Steel con-

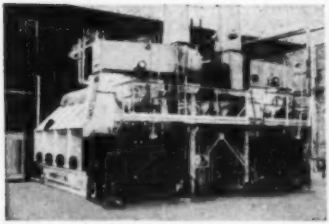
nectors insure great flexibility and eliminate stretch. Leather segments are "V"-faced to provide a double bevel which conforms to standard "V"-belt sheaves. The double "V" feature prolongs the useful life of the belt since on straight drives it can be turned over to become the equivalent of a new belt.

***( Continued on page 20 )***

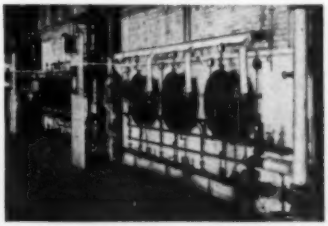
# *NOW . . . Coppus-Dennis FANMIX Action REVOLUTIONIZES OIL BURNER PERFORMANCE 6 WAYS!*

1. **INCREASES BOILER RATINGS** because all of your furnace space is used for combustion . . . none for mixing.
2. **STEPS UP FUEL EFFICIENCY** because complete combustion is guaranteed with 5% to 10% excess air.
3. **GETS RID OF "HOT SPOTS"** because continuous explosion kills torch action and disperses heat uniformly.
4. **ELIMINATES FORCED DRAFT EQUIPMENT** because FANMIX action itself overcomes the entire draft loss across the burners.
5. **CUTS STACK REQUIREMENTS** because the forced draft created by FANMIX action calls for less furnace draft.
6. **REDUCES COKING OF ATOMIZERS** because their tips are air-cooled by the fan blades to a point well below the coking temperature.

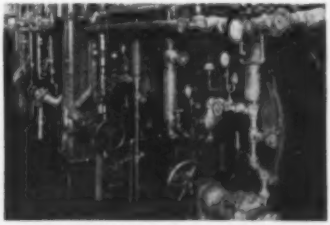
**COPPUS-DENNIS FANMIX OIL BURNERS,** thoroughly proved in important installations for more than two years, utilize jet reaction of steam-atomized oil to rotate a fan which is an integral part of the burner. Automatically adjusted proportion of high velocity air passes at right angles through the sheet of atomized oil to create an ideal mixture for fast, complete combustion — peak efficiency.



**COMMERCIAL SOLVENTS CORP.** plant, Terre Haute, Indiana, utilizes Coppus-Dennis FANMIX Oil Burners to fire two fully automatic 250 hp steam generators. Installed early in 1948, these two units have since been supplemented by a third.



**AMERICAN WOOLEN CO.,** in one of its plants, has equipped two 1000 hp boilers with six Coppus-Dennis FANMIX Oil Burners.



**BROCKTON EDISON CO.** relies on four Coppus-Dennis FANMIX Oil Burners in its plant in East Bridgewater, Mass.

ANOTHER
**COPPUS**
"BLUE RIBBON" PRODUCT

**INVESTIGATE!** If you share in the responsibility for the efficiency of your firm's boiler operations, it will pay you to learn why Coppus-Dennis FANMIX Oil Burners, made to Coppus Blue Ribbon standards of quality, promise such superior performance. Send the coupon today.

**Please attach this coupon to your company letterhead**

**COPPUS ENGINEERING CORPORATION**
189 Park Avenue
Worcester 2, Mass.

Please send complete data on Coppus-Dennis FANMIX Oil Burners.

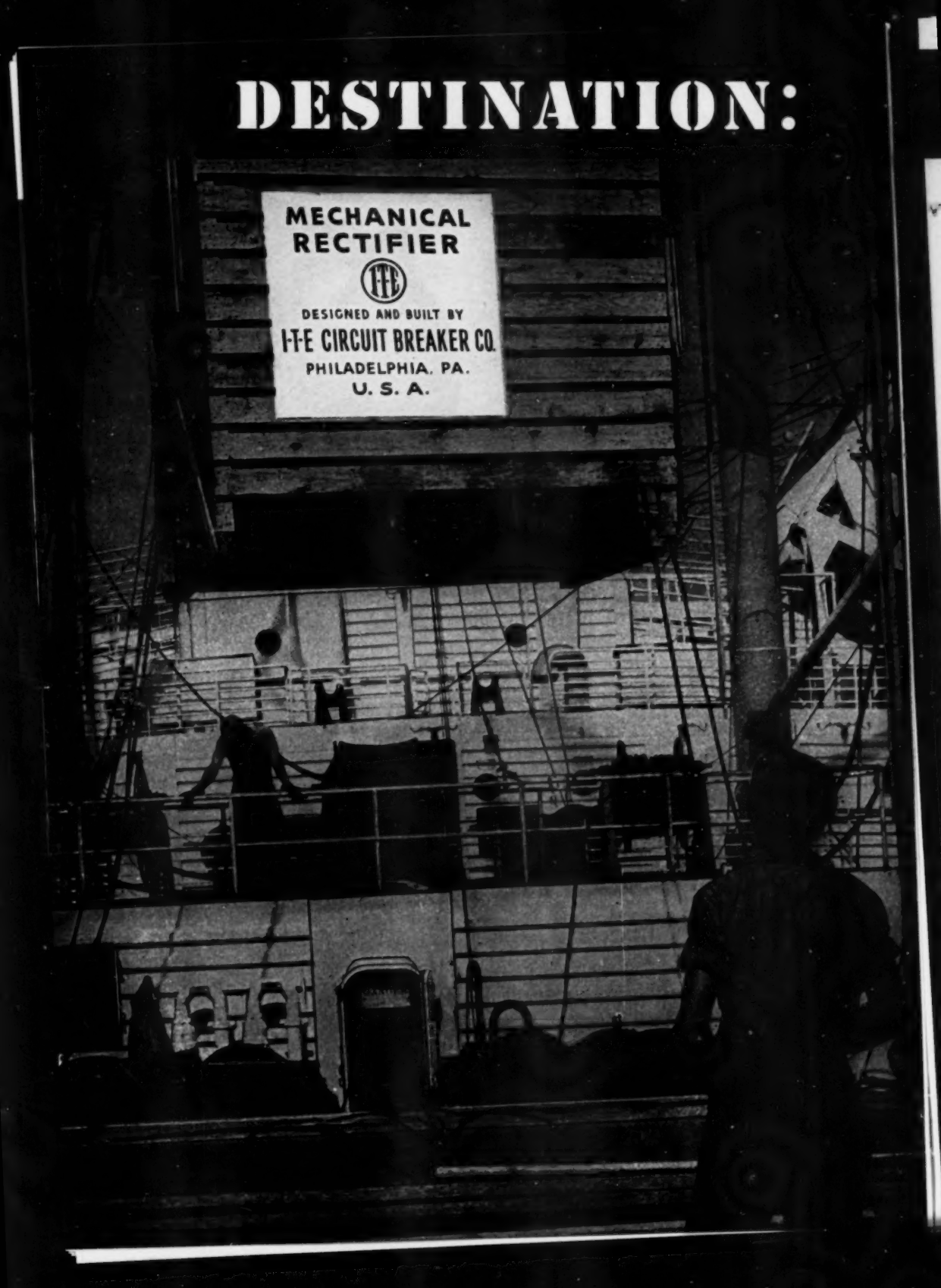
Name ..... Title .....

Company .....

Address .....

City ..... Zone ..... State .....

# DESTINATION:



# MANILA

## I-T-E Mechanical Rectifier to Provide D-C Power for Philippine Chlorine Production

Otto Jensen (right), manager of the Rectifier Division, I-T-E Circuit Breaker Company, Philadelphia, explains cathode ray oscilloscope reading of contact timing on new mechanical rectifier installation for the Superior Gas and Equipment Company, Manila, Philippine Islands. Observing the demonstration are (left to right) D. Tiosejo, Vice President of the Philippine company; H. G. Noordberg, Vice President; and B. D. Van Eyck, Industrial Equipment Manager, Philips Export Corporation of New York.

**PHILADELPHIA:** A step toward making the Philippines independent of outside chlorine supplies was taken recently when the first I-T-E Mechanical Rectifier manufactured for export was shipped to Manila from the Port of Philadelphia.

The rectifier will be put into operation this fall in a new $700,000 chlorine plant near Manila. The plant will produce an estimated six tons of chlorine daily for water chlorination, bleaching, and civil defense purposes.

Designed to produce an uninterrupted source of d-c power for plant operation, the rectifying equipment has a rating of 12,000 amperes at 65 volts.

The rectifier was purchased through Philips Export Corporation, New York City, by the Superior Gas and Equipment Company, Manila, whose Chief Engineer and Director, M. I. Felizardo, and Vice President, D. Tiosejo, supervised acceptance tests at the I-T-E Philadelphia plant.

Deciding factors in Superior's selection of rectifying equipment were the mechanical rectifier's high inherent efficiency (96.6%), the small space requirement, low maintenance cost, and ease of operation.

---

I-T-E Mechanical Rectifiers are available in units rated from 4,000 to 10,000 amperes, in any voltage from 50 to 400 volts d-c. Primary voltages, 2,300 to 22,000, three-phase a-c.

I-T-E Bulletin 5106 contains complete technical information on the Mechanical Rectifier, including a detailed presentation of operating principles. Send for it today. I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa.

The I-T-E Company

# Get TWICE the value for your steam trap dollar!

Just as the self-starter revolutionized the automobile, so Clark Duo-Step Leverage is changing old-fashioned ideas about steam trap efficiency.

Field and laboratory tests prove that Clark DUO-STEP Steam Traps more than *double* the drainage capacity of ordinary inverted bucket traps.

Ask your Clark representative for a demonstration on your steam lines—or write us for complete information.

Here's how DUO-STEP doubles drainage capacity

**THE CLARK MANUFACTURING COMPANY**
**1845 East 38th St. • Cleveland 14, Ohio**

**Clark**
THE HOME OF DUO STEP LEVERAGE

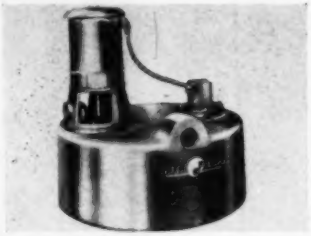
The complete line of dependable fluid controls


## New equipment and developments

*( Continued from page 16 )*

### 17—CONDENSATE RETURN UNIT HAS WIDE USE RANGE

Compactly designed to occupy the minimum of floor space, these vertical Roth condensate return units are versatile for applications up to 8000 sq ft EDR at 20 psi. Two sizes cover this range. Made by Roy E. Roth Co., the unit handles water to 210 F without vapor lock, and the vertical design is particularly intended for installations where the return piping is close to the floor level. Also, the unit can be installed in a shallow pit, when desired, without risk of flooding the motor, which is mounted vertically above the pump and receiver. Supplied as a complete assembly, the unit includes pump, receiver, enclosed float switch and single phase or three phase motor. Simplex or duplex units are available.

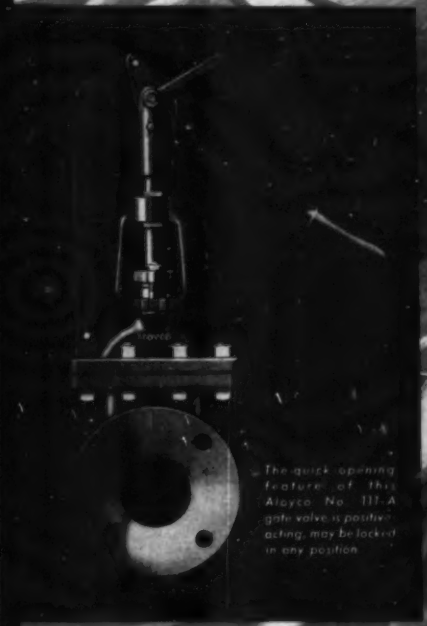


**Additional information on new equipment and development items is available. Use card inserted between pages 140 & 141**

### 18—EXTRA THIN ELECTRICAL TAPE RETAINS ADHESIVE

A new type electrical tape, made with Koroseal material, and said by the manufacturer to have many advantages over ordinary electrical tapes is announced by The B. F. Goodrich Co. It is reported that the adhesive is non-transferring, and can be pressed onto a dry surface innumerable times without losing its stickiness. It will not transfer the adhesive from the face, lose

*( Continued on page 22 )*




# Lasts longer in corrosive service

**This quick-opening gate valve is one of a wide range of ALOYCO valves recommended for severe corrosive services. Its long life expectancy results from ALOYCO's:**

**A. metallurgical research devoted *exclusively* to corrosive applications;**

**B. foundry and machine shop facilities set up for high alloy valves *only;***

**C. casting and machining practices dictated by the difficult characteristics of the alloys required for corrosive services.**

## Success Stories from ALOYCO's Corrosion Clinic

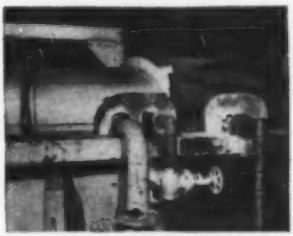
**THE CORROSIVE:** Concentrated sulfuric acid.

**THE APPLICATION:** Supply line to continuous cold sheet pickler.

**THE PLACE:** Largest steel mill on Eastern seaboard.

**THE VALVES:** Two ALOYCO 20 globe valves.

**THE RESULTS:** Former cast-iron valves gave trouble sticking and freezing, both open and shut, and required frequent replacement, losing production time. Original ALOYCO 20 valves have eliminated this difficulty entirely. Customer has replaced all cast-iron valves in this service with ALOYCO.



***ALOYCO globe valve on sulfuric acid supply line to continuous sheet pickler.***

**THE BACKGROUND:** When a customer can report "Best acid valve I've ever seen", that's good evidence that the special procedure ALOYCO uses in making corrosion-resistant valves pays off in lower valve costs and protected product purity.

ALOYCO *concentrates* on valves for corrosive services. We make no other types. Our foundry practices, our machines and our tools are designed for the production of high alloys alone.

And our *Aloyco Corrosion Clinic* specializes on problems of corrosion, contamination, discoloration, high and low temperature service.

If *you* have such problems in your plant, put them up to the *Aloyco Corrosion Clinic* for "diagnosis" and "treatment".

**ALLOY STEEL PRODUCTS CO., INC.**
**1305 West Elizabeth Avenue, Linden, N. J.**

Longer Lasting

# ALOYCO VALVES

1st in Corrosive Service

# IS THIS HELPFUL INFORMATION AT YOUR FINGER-TIPS?

If you use tube maintenance tools, cleaners, expanders, accessory tools, or are in any way connected with their purchase, you should become thoroughly familiar with the contents of these AIRETOOL bulletins:

Helps you select the RIGHT cleaners and expanders for best results in straight and curved tubes. Bulletin No. 44

Get the facts about how specially designed lightweight cleaners safely remove scale from condenser and heat exchanger tubes. Bulletin No. 40

Tubes can now be rolled to amazing accuracy and with TWICE the speed by means of this new control fully described in this bulletin. Bulletin No. 47

The handy tools described in these bulletins will reduce your down-time and increase your profits. To obtain your free copies of these colorful bulletins, write The AIRETOOL Mfg. Co., 318 S. Center St., Springfield, Ohio.

*There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction.*

BRANCH OFFICES: New York, Philadelphia, Chicago, Tulsa, Baton Rouge, Houston


# New equipment and developments

*( Continued from page 20 )*

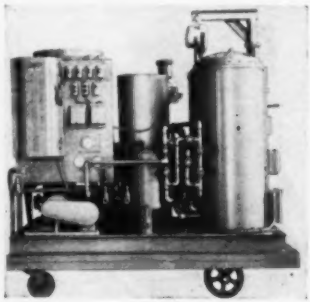
its tackiness or ability to adhere, sticks securely to itself and insulation around copper wire.

The tape has a dielectric strength of 8000 v, is waterproof, highly abrasion resistant and flameproof, resistant to acids, oil, alkalies and corrosive salts. It is extra thin, takes up less room in junction boxes and other tight quarters, stretches and conforms readily to irregular surfaces. The tape comes in a roll 60 ft long, is ¾ in. wide and 0.007 in. thick and is packaged in a metal container.

**Additional information on new equipment and development items is available. Use card inserted between pages 140 & 141**

## 19—PURIFIER SAVES INSULATING OILS

Power interruptions and breakdowns caused by contaminated insulating oils in transformers and circuit breakers are claimed to be eliminated with the Houdaille Purivac, a complete mobile purifying unit for insulating oils, developed by the Honan-Crane Corp. The unit removes all acidity, moisture and sludge and restores interfacial tension and dielectric strength of oil,



all in one operation. Purivac consists of two purifiers, heat exchanger, dehydrating and degasifying unit, electrical control panel, pumps and motors, the entire assembly mounted on a steel base for adaptation to transportation and handling. The two purification units may be operated separately, in parallel, or in series as desired. Purification of insulating oil can be performed in the field or at a central station. In the field it can be connected to the transformer and operated while the transformer is in service or out of service.

## 20—PACKING DESIGNED TO SAVE SPACE

Johns-Manville has developed an automatic ring packing called "Uneepac". It is a molded packing and each ring is a com-

*( Continued on page 152 )*

EASTERN GAS AND FUEL ASSOCIATES

PITTSBURGH BOSTON CHICAGO CLEVELAND DETROIT NEW YORK
NORFOLK PHILADELPHIA SYRACUSE

*For New England:* New England Coal & Coke Co., *For Export:* Castner, Curran & Bullitt, Inc.

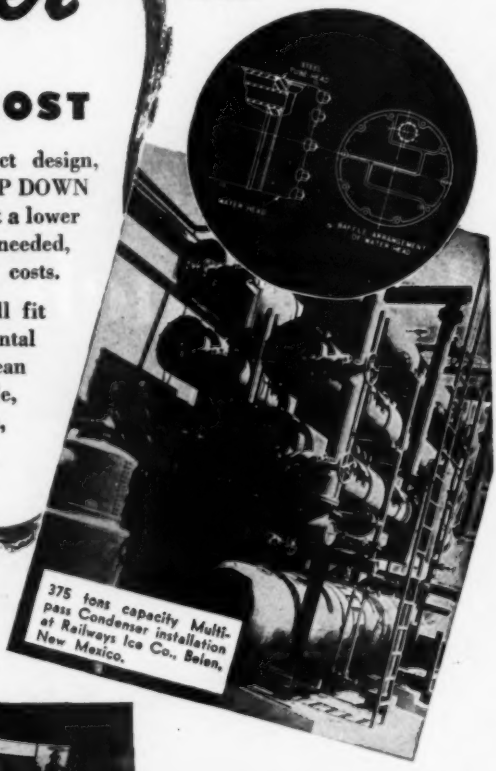
# $ave Power and REFRIGERATION COST

Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

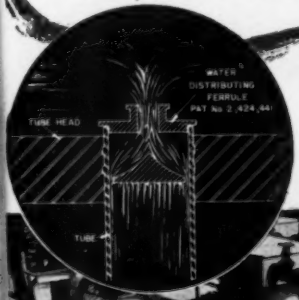
One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

**Horizontal Multipass Condensers**
(Closed Type)

Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.

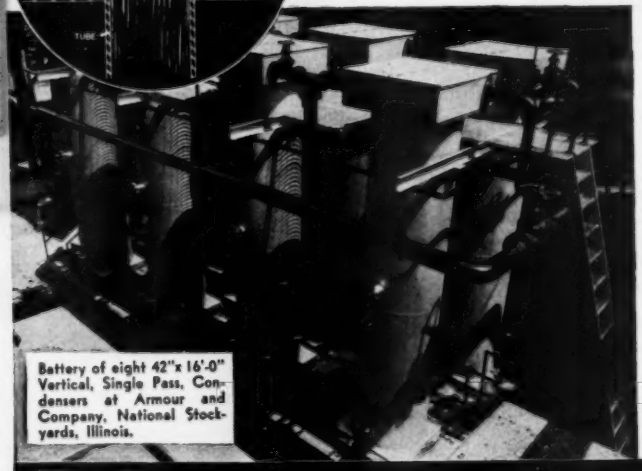


375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.




**Vertical Single Pass Condensers**
(Film Type)

Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

## HORIZONTAL and VERTICAL TYPES SHELL and TUBE CONDENSERS For Every Service

*Write For Bulletin RC-1*

**HENRY VOGT MACHINE COMPANY**
INCORPORATED
1000 W. ORMSBY ST., LOUISVILLE 10, KY., U.S.A.
Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

# Vogt REFRIGERATION CONDENSERS

*now you can reduce steam costs with the automatic*

**Powermaster®**

Model 3 *Powermaster*—15 to 500 H.P.; high or low pressure models for steam or hot water.

Exclusive burner design (patent applied for) is yours with the *Powermaster* steam generator. Compare this unit with others and you'll see why users are saving hundreds of dollars on fuel bills. Only the *Powermaster* gives you these 3 definite ways to reduce your costs for steam or hot water—

1. *Use less fuel* when boiler operates between 100% and 30% of capacity. Special burner gives you full modulation in a wide range between high and low fire.

2. *Save clean-up time* and money because complete combustion of fuel gives practically smokeless and carbon-free operation. Case histories show that the *Powermaster* needs cleaning less often than other self-contained units.

3. *Change from oil to gas* (or gas to oil) in just a few minutes. Take advantage of low fuel rates, enjoy freedom from worry about fuel shortages.

*only the* **Powermaster®** *gives you all 3 advantages*

***Write for this catalog***

that gives you the entire story of the *Powermaster* steam generator. Just ask for Catalog 1218 and we'll put one in the mail for you.

**ORR & SEMBOWER, INC.,** *Established 1885*
950 Morgantown Road, Reading, Pennsylvania

# For Features that Mean Long Valve Life and Low Cost Service Get this ALL-Purpose Edward Forged Steel Globe Valve

Edward Fig. 444-448 series, built in sizes ¼ to 2 in. inclusive . . . forged steel globe and angle . . . 600 and 1500 lb sp . . . bolted or union bonnet . . . screwed or socket welding ends . . . Fig. 448 illustrated.

## CHECK THESE Big FEATURES

- ✓ Hard bronze yoke bushing to prevent stem seizing or galling . . . lock welded to yoke
- ✓ Packing is Edward EValpak . . . heat resistant, water-proofed and die molded for long service
- ✓ Disk of EValloy 13% chromium or Stellite . . . slotted or disk nut type . . . self centering
- ✓ Tight, easily accessible bolted or union bonnet joint . . . with ironkote gasket of 90 Brinnel max. hardness for leak-proof joint
- ✓ Heat treated forged steel inclined stem globe type body for lowest pressure loss
- ✓ Built-in pressure-tight backseat . . . permits repacking under pressure
- ✓ Roomy forged yoke . . . plenty of finger space for repacking
- ✓ Strong forged gland bolts . . . plated for long thread life

Edward Valves, Inc.
40 West 144th Street, East Chicago, Indiana

Please send literature covering your Fig. 444-8 series all-purpose forged steel valves.

Name_____

Company_____

Position_____

Address_____

City_____ Zone____ State_____

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

# New bulletins and catalogs

***You'll want to check these new bulletins and catalogs carefully as they have been screened by our editors to make sure they contain new information of value to you.***

**See Reader Service Card Page 140**

### BOILERS, AUXILIARIES, ACCESSORIES

**200—Finishing-Insulating Cement.** Illustrated folder describes finishing cement that insulates. Shows economical advantages and gives characteristics of the material. Includes thermal conductivity chart. Baldwin-Hill Co.

**201—Refractories.** Technical information of a basic nature on line of refractory products is given in 20-page booklet 5120. Suplemented with charts, tables and illustrations that make it valuable aid in selecting proper refractory. Refractories Div., The Carborundum Co.

**202—Industrial Insulation.** Cements, flats, fills, pipe coverings, protective coatings and anti-condensation compounds are covered in 22-page bulletin A91. Characteristics of each type along with application data are given. Contains seven pages of engineering data including charts on recommended thickness, heat losses, and formulas for calculating heat savings along with many reference tables. The Eagle-Picher Co.

**203—Fuel Oil Additive.** Concentrated chemical liquid added to fuel oil in tank is described in 4-page folder. Said to remove soot and carbon scale and aid in keeping burner nozzle and oil system clean. Tells advantages and gives directions on the use of the product. Lubaid Co.

**204—Forced Draft Fans.** Bulletin 300, 8 pages, describes design features of forced draft fans. Illustrates various types of fan-wheels, designed with backward curved blades. Various types of housing are also shown. Prat-Daniel Corp.

**205—Electrode Steam Boilers.** Let Speedylectric put steam to work for you. Designed to hold exact steam pressure and temperature, this line of electrode steam boilers is briefly described in 4-page folder 31. Refers you to bulletin for more specific information. Pressures up to 500 psi and volumes to 750 lb of steam per hr. Livingstone Engineering Co.

**206—Oil Valves.** Catalog 704A, 4 pages, gives details on oil valves for controlling the flow of oil to industrial oil burners. Discusses the precise metering feature which is helpful in preventing smoke by avoiding excess amount of oil. Hauck Mfg. Co.

**207—Over-Fire Air Systems.** "Burn the smoke" for cleaner, more efficient coal heating, says Canton Stoker and then shows how it's done in 8-page bulletin on Turbo-Aire over-fire air systems. Contains thorough discussion on principles of combustion and smoke elimination. Gives full description of the equipment along with cutaway and diagrammatic views showing units in action. Selection chart, specifications, and fan data and characteristics are included as is brief description of automatic controls. Three types of stokers are illustrated and short descriptions given. Canton Stoker Corp.

### PRIME MOVERS: DIESELS, TURBINES, COMPRESSORS

**208—Diesel Engines.** Comprehensive bulletin illustrates and describes type FV diesel engines. Gives complete engineering data, specifications and power ratings. Lists such applications as locomotive service, draglines and electric power generation. Available in 6, 8, 12 and 16 cylinder types. The Cooper-Bessemer Corp.

**209—Asbestos & Fibre Sheet Packings.** 8-page bulletin features complete line of asbestos and fibre sheet packings. Gives complete description and illustrations of each type packing, together with full service recommendations, standard sheet sizes, and weights and thicknesses in which each type sheet is available. Raybestos-Manhattan, Inc., Packing Div.

**210—Diesel Oil Additive.** Folder tells what this solvent is and what it does to aid in efficient engine performance. Includes directions and proportions for applying. Lubaid Co.

**211—Turbine Oil Maintenance.** Bulletin 832P, 12 pages, describes and illustrates dry-type oil maintenance methods for turbine bearings. Importance of continuous oil maintenance, and factors which cause turbine oil deterioration are fully explained by charts, diagrams and phantom views. Various types of turbine oil maintenance systems are shown with their capacities and dimensions. Also covers system for maintaining insulating oil dielectric in transformers, circuit breakers and switches. Bowser, Inc.

**212—Compressors.** Heavy-duty, cross-head type, 100 psi, two-stage air compressor in sizes from 125 to 350 hp is illustrated and described in 20-page bulletin 3150. Gives full details on design, ratings, lubrication, controls, capacity and motor drive. Cross sections illustrate the many engineering features and construction advantages. Exploded photos show bearing and crank shaft assembly and lubrication system. On-the-job photos included. Ingersoll-Rand Co.

**213—Diesel Engine.** Medium-speed, heavy-duty continuous service engine with 3, 4, 5, 6, 7 and 8 cylinders, rating from 225 to 600 bhp at 720 rpm is illustrated and described in 36-page bulletin 10,310A. Full discussion on injection system and other design features is contained. Gives installation and maintenance data along with information on lubrication, cooling and starting systems. Specifications, ratings, dimensions shown in diagrammatic and tabular form. Typical applications and installation photos included. Ingersoll-Rand Co.

**214—Gas Turbine.** Two-color 16-page booklet GEA5530 on gas turbine for pipeline pumping describes the features of the equipment, its application and operation. Illustrated with photographs, line drawings, and charts showing hp limits for various ambient temperatures. Breakdown chart showing components of the turbine is included as well as sketches showing typical installation buildings. Gas turbine control, remote supervisory control, and accessories are also listed. General Electric Co.

### HEAT EXCHANGERS

**215—Heat Exchangers.** Equipment for distribution and utilization of steam, gas and liquid is briefly described in illustrated folder 349. Refers to specific bulletin for more detailed information. Eight types of expansion joints, four heat exchangers and several types of meters and strainers are shown. Also pictures and describes various accessories for pipe lines. American District Steam Co.

### WATER AND LIQUID TREATMENT

**216—Return Line Corrosion Control.** Bulletin 5013, 4 pages, covers causes of return line corrosion and recommends and explains corrective treatments. Includes information on clear amine type liquid which dissolves in the condensate, and reacts with carbon dioxide preventing carbonic acid, and filming-type amine which forms continous film in return lines, coating them against both oxygen and carbon dioxide corrosion. Also contains test procedures for both treatments. Dearborn Chemical Co.

**217—Zeolite Softeners.** Thorough explanation of the sodium zeolite softening process is contained in 32-page bulletin 4520. Tables and discussions on

# New bulletins and catalogs

*( Continued from page 27 )*

rating and zeolite selection make it easy to choose correct size and material for specific conditions. Describes hydromatic single control valve and its advantages along with other features. Cutaways, exploded photos and diagrams illustrate some arrangements possible with the units and accessories. Installation photographs included along with brief descriptions of other water conditioning products. Cochrane Corp.

**218—Deionizer.** Bulletin 512, 6 pages, describes single tank deionizers of mixed-bed, monoflo design. Lists features and explains economical benefits as compared to other methods of purifying water. Said to produce water free from all ionizable impurities including carbon dioxide and silica. Engineering and technical data covering sizes included. Elgin Softener Corp.

### FILTERS, STRAINERS, CLARIFIERS, DEHYDRATORS

**219—Purifier.** Condensed bulletin 100 fully describes the operation, specifications, dimensions and features of internal type purifier said to remove virtually 100% entrainment from vapor. The 4-page folder contains dimensional drawings illustrating the use of purifiers inside two typical installations, steam drums and bubble-cap towers, as well as cutaway drawing showing vapor flow through the unit. Recommended applications are listed. Steam Specialty Div., V. D. Anderson Co.

**220—Aftercoolers & Separators.** Cool, clean, dry air means high efficiency and economy in the use of compressed air. See how it's accomplished in 8-page bulletin 176. Includes full discussion along with illustrations on equipment required to do the job. Specifications and dimensions included. R. P. Adams Co., Inc.

**221—Industrial Dust Control.** General information on the subject of industrial dust control is contained in 24-page bulletin 98. Explains basic principles applied to solution of dust problems. Diagrams show just how filters work and tables give capacities and dimensions of the units. Illustrates and discusses equipment and accessories. Contains much helpful data for those concerned with dust control. The W. W. Sly Mfg. Co.

**222—Porous Media.** Knowledge of porous media should prove helpful in solving many filtration and air diffusion problems particularly in the water and sewage treatment fields. Booklet 5118, 56 pages, provides a great deal of information and data on aluminum oxide porous media. Contains discussions, drawings, diagrams, photographs, charts and tables to assist in the specification of porous material that will accomplish desired results. Refractories Div., The Carborundum Co.

**223—Underdrain System.** Bulletin 5128, 4 pages, gives particulars on baffle plate type of underdrain system for purifying water. Said to be non-clogging and to provide even back-wash distribution. Cutaway views show how the system works. General Filter Co.

### ELECTRICAL EQUIPMENT

**224—Single-phase Inductrols.** Bulletin GEC795, 18 pages, describes features of redesigned inductrol equipment, its application and operation. Also contains sketches, line drawings, and charts showing operating connections. Price and purchasing data on the equipment, rated 0.3 to 24 kva, for use in circuits rated 3 to 240 kva, is included. General Electric Co.

**225—Packaged Power.** Bulletin GEA 5600 outlines methods of obtaining electric power equipment for quick expansion with a minimum of critical materials. 52 photographs and diagrams explain the result of using "packaged" electrical systems. Said to eliminate the need for individually engineered assembly of piecemeal components. Also offers a list of 31 other G-E bulletins giving full information on available equipment for industrial power expansion. General Electric Co.

**Bulletins and catalogs reviewed here are yours for the asking. Use card inserted between pages 140 & 141**

**226—Voltage Regulators.** Bulletin S3-51, 12 pages, features complete line of standard Stabiline automatic voltage regulators. Describes in detail the workings in maintaining constant output voltage regardless of fluctuations in a-c input line voltages and changes in output load. Standard models of both instantaneous electronic and electro mechanical types are discussed. Illustrates each unit together with outline drawings and performance data. Complete rating chart provides engineering information for ease in selecting units for specific applications. The Superior Electric Co.

**227—Circuit Breaker Panelboards.** Circuit breaker panelboards for the control and protection of power applications—and the circuits that supply them—are described in 20-page booklet B5260. Describes circuit breakers for a complete range of industrial requirements, in capacities from 10 to 600 amp. Says that features of the breakers are service continuity protection, protection to personnel, and no replacement costs. Westinghouse Electric Corp.

**228—Carbon Brushes.** Bulletin GEA 5597, entitled "Carbon Brushes for Electric Equipment", describes and illustrates the fundamental considerations given to the design, application, and manufacture of carbon brushes and includes a section on brush terminology. Produced to familiarize users with the physical characteristics that must be known before proper recommendation can be made for a brush application, the 28-page booklet also tells of the engineering services offered to help solve specific brush problems. Included are sections on types of brushes, characteristics of brush grades, brush grade recommendations, mechanical design of brushes, and tips on brush replacement. General Electric Co.

### INSTRUMENTS, CONTROLS, RECORDERS

**229—Oxygen Recorder.** Magno-Therm oxygen recorder is fully described in 16-page illustrated bulletin 51-829. Includes application table showing where, how and why the instrument is used; complete explanation of how an analysis is made; detail photos and discussion of features; operation of various gas sampling systems used with the instrument; and chart-illustrated discussions of results obtained with the $O_2$ recorder in several installations. The Hays Corp.

**230—Combustion Controls.** Information on full line of combustion controls is contained in 12-page bulletin C512H. Lists features of each unit and suggests applications. Photographs show component parts, while sketches give dimensions. Drawings of typical installations show how the units work. Specifications are included along with discussion on what combustion instruments and controls should be specified. Cleveland Fuel Equipment Co.

**231—Temperature Regulator.** Bulletin 316 describes and illustrates regulator said to provide accurate control over liquid or air temperatures in wide variety of industrial applications. Features of construction and operation are discussed. Diagrams show typical applications as well as available accessories. Two types of diaphragm valves for control applications also are pictured and described. The Powers Regulator Co.

**232—Utility Tester.** Data sheet gives information on instrument for testing all electrical circuits and utilities as well as all motors to 2 hp. Explains just what the unit will do to help solve testing problems. Superior Electronic Co.

**233—Regulators & Controllers.** How to solve your pressure and temperature control problems by using selection charts is explained in 4-page bulletin 502. Gives advantages and features on line of regulators for regulation and control of pressure, temperature and liquid level. Includes photographs and cutaway views. Leslie Co.

**234—Industrial Strain Gages.** Four ways in which these weighing units are being used for industrial weighing are briefly described in 4-page bulletin. Applications include continuous weight integrator for materials carried by belt, crane hooks, multi-tank weighing and batch control of liquids. Baldwin-Lima-Hamilton Corp.

**235—Draft & Low Pressure Instruments.** Fully indexed, 20-page bulletin 51-667 describes and pictures line of draft and low pressure instruments.

***( Continued on page 32 )***

# You Save on 4 Counts with

# ENCO

## STREAMLINED BAFFLES

### 1 Better heat transfer

Enco's improved baffle design insures a uniform, high velocity gas flow over every square foot of heating surface.

### 2 Low draft loss

Smoothly curved baffles maintain a cross-flow of gases across the tube banks. Dead gas areas, bottlenecks and eddy currents are eliminated.

### 3 Less steam, less time for cleaning

Soot doesn't get a chance to accumulate in pockets. Soot blowers are used less often. Streamlined baffles lower maintenance costs.

### 4 Custom installation

Experienced Enco crews take charge of the installation, repairs and replacements of your individually designed streamlined baffles—do the job thoroughly and quickly with minimum downtime.

**BULLETIN BW44** tells the full story, contains complete engineering data, explains how Enco Baffles provide maximum steam output with minimum fuel consumption. WRITE FOR YOUR FREE COPY TODAY!

**THE ENGINEER COMPANY**

**75 WEST STREET, NEW YORK 6, NEW YORK**

**IN CANADA: F. J. RASKIN, LTD., 4220 IBERVILLE ST., MONTREAL 34 P.Q.**

# Take a "tall bite" out of

## bring them down with these

## V-Belts by

# high power costs!

# DAYTON COG-BELT* "teeth!"

**✓ 40% MORE H. P. PER BELT ✓ FEWER BELTS**
**✓ FEWER PULLEY GROOVES ✓ LONGER BELT LIFE**

**Want to save 2 V-Belts** on every 7-belt drive, more on bigger drives? You can with the premium Dayton Cog-Belt because each belt delivers 40% more horsepower, as 5 Cogs do the work of 7 ordinary V-Belts!

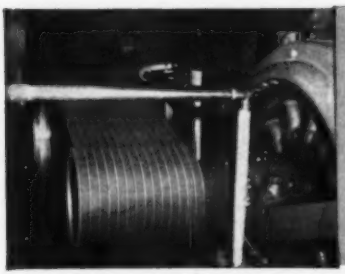
The reason: Cogs are the only V-Belt scientifically built to bend like your finger, for easy flexing, as the belt arches round pulleys. Compression strains are minimized, gripping power is increased. Cogs run cooler and last longer.

**Want to save space?** Cog-Belts let you use shorter center-to-center pulley distances—as much as 25% shorter.

**Want to forget about V-Belts for the duration?** Then convert to Cogs and their "40% Plus" performance, while you can. Give your Dayton Distributor the "high sign" of better power transmission—the arched finger that means Cog-Belt savings.

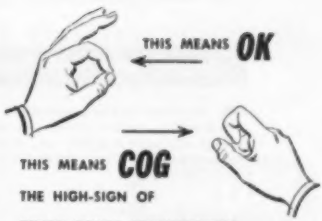
*T. M.

DAYTON RUBBER COMPANY • DAYTON 1, OHIO



**COGS JOG GENERATOR!**

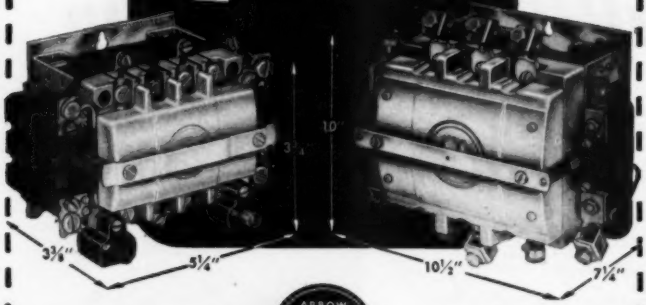
A company making cheese boxes drives its plant generator with a 200 H.P. steam engine. The old flat-belt, countershaft drive never delivered enough h.p. to get maximum output from the generator. The Dayton Distributor sold them on converting to a Cog-Belt V-flat drive, direct to the generator. Now, the new drive delivers *more* h.p., at *slower* engine speed, with *less* fuel consumption, and—gets *maximum output* from the generator!




# Dayton Rubber

**WORLD'S LARGEST MANUFACTURER OF V-BELTS**

MORE
BIG FEATURES
IN JUST
1/2 THE SPACE




SIZE 0
ENCLOSURE DIMENSIONS:
6⅝" x 6⅝" x 3⅜"

ARROW AH HART

SIZE 4
ENCLOSURE DIMENSIONS:
19¼" x 14½" x 8"

TYPE "RA"
MAGNETIC STARTERS

Whatever your requirements in a motor starter, you'll find the *right* unit to do the job *better* in the complete Arrow-Hart line, available in all sizes, 0-1-2-3-4. Straight-thru front wiring exclusive with A-H, means *easy* wiring, easy servicing, easy mounting. The patented A-H *"RA" design* cuts conventional starter size in half—*lets you step up motor size while reducing control size.* Contacts are easy to reach and remove. All in all, Arrow-Hart Magnetic Starters give you more *working advantages* than any other controls on the market. Find out for yourself.

WRITE FOR FREE BOOKLET

Fully illustrated booklet complete with design and operating features, dimensions, ratings, catalog and parts numbers, etc., covering the complete "RA" line — Sizes 0-1-2-3-4 — yours on request.

ARROW AH HART

THE ARROW-HART & HEGEMAN ELECTRIC CO.

ARROW·HART

1209 HAWTHORN ST., HARTFORD 6, CONN.

# New bulletins and catalogs

*( Continued from page 28 )*

Discusses indicators (of seven types), recorders, and controllers. Application table is included to aid in selecting the correct instrument. Features such as calibrating springs, diaphragm units, and differential valve assemblies are explained. Size, scales, ranges, cases etc., of each instrument are illustrated and discussed. In addition, 14 types of draft and pressure, differential and other measuring elements are pictured. The Hays Corp.

**236—Industrial Thermometers.** Bulletin G143B describes and illustrates dial type temperature indicating and recording thermometers. The 8-page booklet shows the wide variety of dial ranges, types of fittings and direct or distant mountings available. Typical applications are listed as are specifications. The Electric Auto-Lite Co., Instrument and Gauge Div.

**237—Rotor Temperature Instruments.** Data sheet 9.1-7 describes strip chart recorder which when coupled with a Kelvin bridge measuring circuit, comprises method of measuring rotor temperatures. Describes method of installation, and also discusses the Kelvin bridge principle. Also lists the required instrumentation, system benefits and other technical data. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

**Bulletins and catalogs reviewed here are yours for the asking. Use card inserted between pages 140 & 141**

**238—Dynamometer.** Bulletin GEA 5-552 presents 250-v d-c dynamometers for direct connection testing of internal combustion engines, electric motors, pumps, blowers, and compressors. Describes features of the equipment, its applications and operation. Illustrated with actual installation photographs, table of full-load hp and speed ratings, and chart showing typical performance curves. General Electric Co.

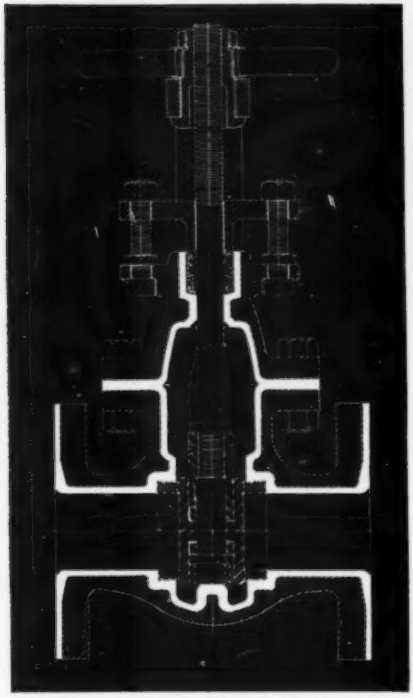
**239—Industrial Meters.** Bulletin OG-400 aids in the proper selection of meters for measuring more than 200 liquids with varying corrosive characteristics. Included are data on liquids running from absorption oil to zinc chloride. Units range in size from ½ to 3 in.; measure in gallons, Imperial gallons, barrels, or liters; have totalizer capacity of up to seven figures; and are available in six types of registers. Rockwell Mfg. Co.

**240—Running-Time Recorder.** Bulletin OP1504 describes running-time recorders. Gives information concerning the

*( Continued on page 159 )*

# HANDLING CORROSIVE FLUIDS?

## this unique hard rubber lined iron body gate valve offers big savings in many corrosive services . . .



*Darling 150-pound rubber lined gate valve, with outside screw and yoke, featuring unique parallel seat, fully revolving disc principle. Plain "no pocket" discs prevent accumulation of sediment. Darling rubber lined gate valves can be furnished only in rising stem, cylinder or motor operated; or quick-opening types.*

WHEN Darling gate valves of this type go to work, you gain *multiple* advantages sure to save you money *and* time.

*First,* you gain big initial savings because these rubber lined iron body gate valves (ideal for many corrosive services not exceeding 180° F.) are much less expensive than special alloy valves. Moreover, Darling's special bonding technique permanently prevents separation of the hard rubber lining from the valve body.

All interior working parts are made of alloys suitable for the corrosive conditions encountered.

*Secondly,* and equally attractive, is Darling's exclusive *fully revolving double disc, parallel seat* feature! In a nutshell this means drop-tight closure where most other valves would fail. It also assures unmatched life with a very minimum of attention and maintenance.

Here's a combination you just can't beat! Before you buy gate valves of *any* type, get acquainted with these unique Darling valves and their operating details. Get *all* the facts.

*Write today for free bulletin describing Darling rubber lined gate and check valves.*

**DARLING VALVE & MANUFACTURING CO.**

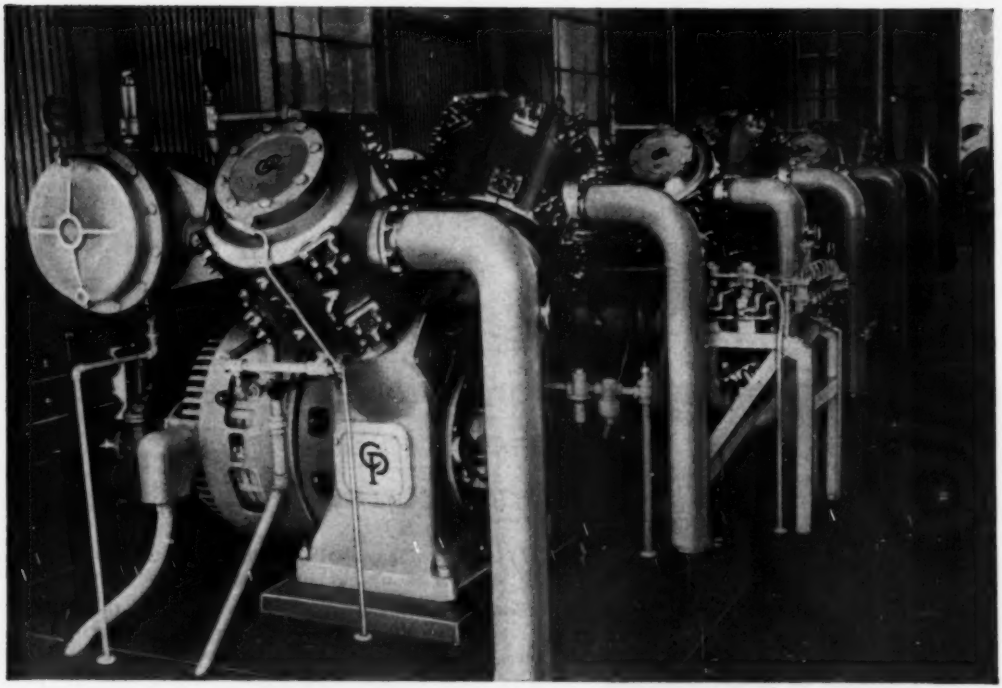
**Williamsport 9, Pa.**

*Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd. Galt 19, Ontario*

### DARLING VALVES FOR EVERY NEED

Darling parallel seat revolving disc gate valves are available in a wide range of sizes and constructions for all kinds of normal and unusual service, and for pressures up to 1500 pounds. In addition to rubber lined, iron body valves, corrosion resistant types include plain iron body with special alloy trim, cast steel, all bronze, special alloys or combinations as required. We'll gladly furnish specific recommendations on the proper valves for your particular service.

**FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN**



# FOR HEAVY DUTY

## COMPACT, EASILY INSTALLED TYPE Y COMPRESSOR

**Where floor space is limited, and continuous, heavy duty service is required, the Type Y Compressor is ideal. Available with direct-connected, flange-mounted synchronous or squirrel cage motor.**

**The Type Y Compressor is easy and inexpensive to install, requiring only a simple foundation. No aligning or leveling is necessary.**

**CP features that assure high efficiency and low maintenance include large area Simplate valves, multi-step capacity regulation, effective inter-cooling, precision bearings and force-feed lubrication.**

**Built in sizes from 75 h.p. to 250 h.p., 501 c.f.m. to 1663 c.f.m.; available also with belted and coupled motors.**

***Write for Bulletin 766***

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 8 East 44th Street, New York 17, N. Y.

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES
ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

# Now more important than ever to you...

Fast **LOCAL** delivery

Convenient **LOCAL** warehouses

On-the-spot **LOCAL** lubrication engineering

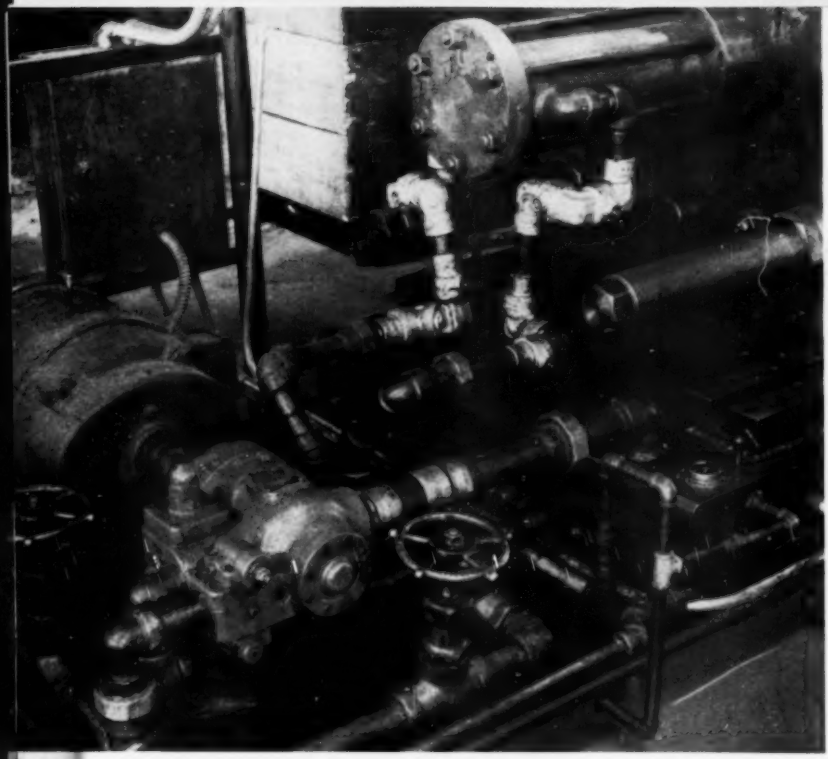
## Standard's LOCAL Lubrication service

• Wherever you are located in the Midwest, there's a Standard service-supply center close at hand. That means prompt delivery of Standard products, immediate assistance from a Standard lubrication specialist.

There's no need to worry over possible production delays due to lack of the right cutting oil, lubricant, or fuel . . . no need to stock-pile these supplies in your own plant . . . no need to wait for help in solving your lubrication problems.

To take advantage of Standard's time-saving *local* lubrication service (now more important than ever to you) call the Standard office in your area. Or write: Standard Oil Company (Ind.), 910 South Michigan Avenue, Chicago 80, Ill.

**STANDARD OIL COMPANY** STANDARD (INDIANA)



# 5 years, no change of oil

THIS midwestern die casting company called in a Standard Oil lubrication specialist when operations were started over five years ago. One of his recommendations specified the use of STANOIL Industrial Oil No. 18 in the hydraulic unit of the die casting machine shown. Now, after five years of service, this original oil is still in nearly perfect condition. There is no deposit and no varnish in the hydraulic system. There has been no need to clean the system.

This performance is typical of the results gained by STANOIL users who count on its greater oxidation stability and corrosion resistance to deliver trouble-free lubrication in speed reducers, head stock gears, auxiliary turbines, and compressors, as well as hydraulic systems.

The Standard Oil lubrication specialist in your own area can help put the advantages of versatile STANOIL Industrial Oil to work in your plant now. A call to your local Standard Oil (Indiana) office is all that's necessary. Why not do it today?

Standard Oil Company, 910 South Michigan Ave., Chicago 80, Ill.

STANOIL
TRADE MARK
Industrial Oil

## What's your problem?

**D. R. Clay,** lubrication specialist at Standard Oil's Grand Rapids office, helped this manufacturer put hydraulic system lubrication on a trouble-free basis with STANOIL Industrial Oil.

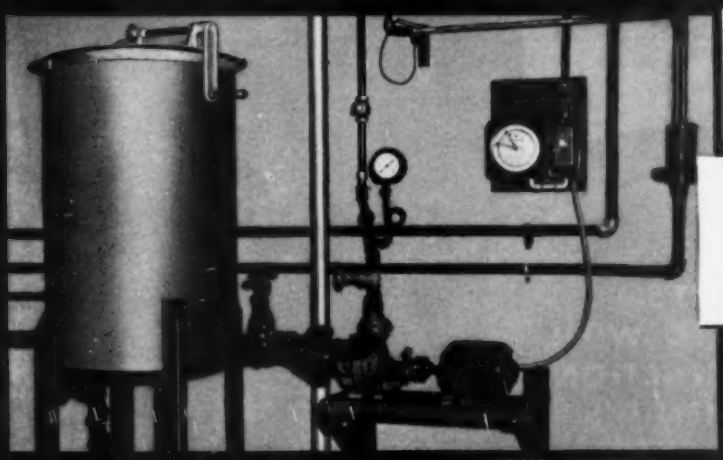
One of a corps of such specialists, he makes his headquarters close to the plants he serves. He offers on-the-spot lubrication service that is backed by extensive experience and training in the application of modern lubricants and fuels. The same service is available to you wherever you are located in the Midwest through the lubrication specialist in your own locality.

Arrange today for a visit by this specialist. Just phone or write the Standard Oil Company office nearest you. When he calls, ask for actual performance data on these outstanding products:

**SUPERLA Greases**—Available in a wide range of consistency grades and in both lime-soap and soda-soap types, SUPERLA Greases cover a wide range of operations.

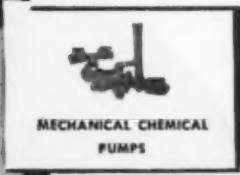
**STANORUST Rust Preventives**—The eight grades of STANORUST form one of the most complete and effective lines of rust preventives on the market today. Each has been scientifically and specially developed for its intended use. The grades range from a fingerprint remover to a heavy semi-solid that protects against corrosion for years under the most severe outdoor exposure.

**STANDARD OIL COMPANY** STANDARD *(Indiana)*

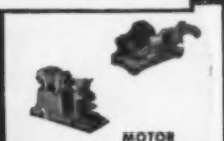


AUTOMATIC INTERMITTENT FEEDING

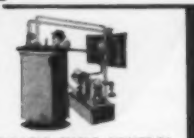
BY-PASS FEEDERS



MECHANICAL CHEMICAL PUMPS



MOTOR OPERATED CHEMICAL PUMPS



AUTOMATIC CYCLE CONTROL

# Dearborn has the ENGINEERED EQUIPMENT for your water treatment

WATER TESTING CABINETS

FLO-CONTROL VALVES —TIMERS

To get the most from your water treatment, it's essential that the entire system be engineered for maximum efficiency.

Here Dearborn will help by analyzing your existing equipment and physical layout. With this information, a Dearborn engineer will then recommend the necessary equipment, whether it is to include a pump or timer—a test cabinet—or an automatically controlled feeding system.

Why not plan to discuss your water treatment and other boiler room problems with your Dearborn engineer? He will bring you all the benefits of Dearborn's broad experience in this field since 1887.

**DEARBORN CHEMICAL COMPANY**

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**WRITE FOR INFORMATION ON THE EQUIPMENT YOU NEED**

*Use the coupon!*

Dearborn Chemical Company, Dept. INP
Merchandise Mart Plaza, Chicago 54, Ill.

- ☐ De-ionizing units
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- ☐ Chemical pumps, mechanical
- ☐ Continuous blow down systems
- ☐ Timers
- ☐ Cooling water samplers
- ☐ By-pass feeders
- ☐ Automatic intermittent feeding
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- ☐ Test cabinets

Please send information on the items checked above.

☐ Have a Dearborn Engineer call.

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*Company*.....

*Position*.....

*Address*.....

*City*.....*Zone*....*State*.....

Dearborn

TRADE MARK REGISTERED

THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

IT'S PACKED WITH SATISFACTION WHEN IT'S PACKED WITH R/M

Typical of the hundreds of different types of equipment packed with Raybestos-Manhattan packings is this high-pressure rotary air compresser. The complete R/M line includes packings and gaskets for service against air, gas, water, oil, steam, petroleum products, chemicals, food products, and practically every gas or liquid used in industry. Your nearby R/M distributor will help select the proper packing or gasket to meet your needs. Or write for the R/M Packing Catalog.

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RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

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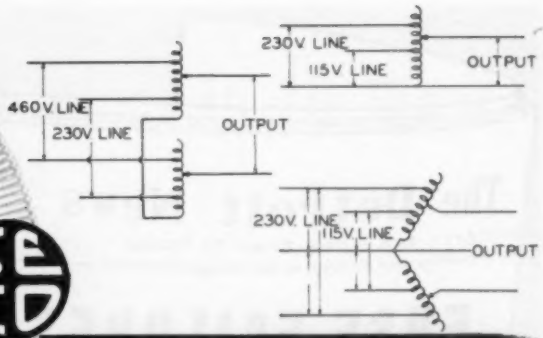
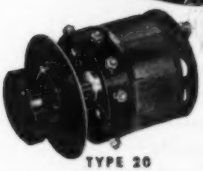
RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Powdered Metal Products • Bowling Balls

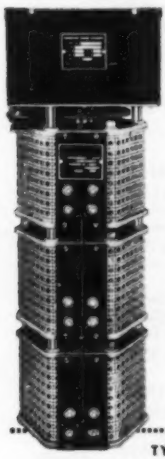
# POWERSTAT VARIABLE TRANSFORMERS




## A TYPE FOR EACH APPLICATION


TYPE 20

TYPE 116


TYPE MZ1126-3Y

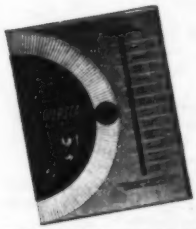
TYPE 2PF1126

**A COMPLETE LINE** of standard manually-operated and motor-driven POWERSTAT variable transformers are available for 115, 230 and 460 volts, 50/60 cycles, single and three phase service in ratings from 405 VA to 100 KVA in air-cooled, oil-cooled and explosion-proof models. Non-catalogued assemblies are offered for 25, 400/800 cycles and higher frequency operation and for requirements involving J.A.N. specifications.

**SUPERIOR PERFORMANCE** is inherent in every POWERSTAT variable transformer. Each unit possesses excellent regulation, high efficiency, conservative rating, zero waveform distortion, rugged mechanical construction, smooth control and simplified mounting.

**ONE SOURCE,** The Superior Electric Company can provide the answer to your variable a-c voltage problem. Superior offers more combinations of connections and ratings for variable a-c voltage control than any other manufacturer. Look to Superior first.

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT



**GET THE FACTS**

16-page POWERSTAT Bulletin P550, complete with application and design information, ratings, diagrams and dimensions.

**1509 CHURCH STREET, BRISTOL, CONNECTICUT**

*SEND ME Bulletin P550 on POWERSTAT Variable Transformers.*

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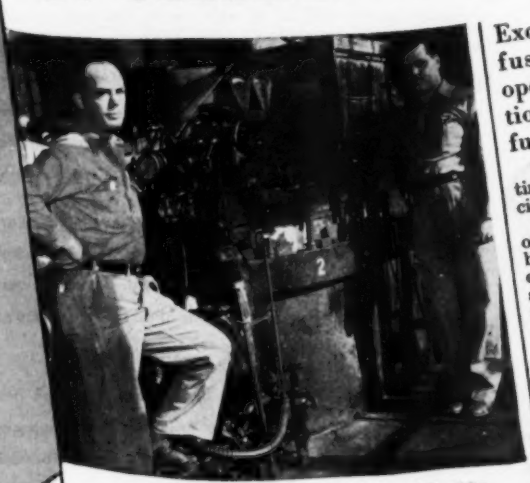
VARICELL D-C POWER SUPPLIES • 5-WAY BINDING POSTS • POWERSTAT LIGHT DIMMING EQUIPMENT

The Detroit News
EWSPAPER FOR MORE THAN 77 YEARS
ree Weekday and Sunday, of Any Michigan Newspaper

# FUSE FAILURES ON LEAD POT CIRCUITS STOPPED COLD — BY CHANGING TO FUSETRON FUSES



Wilbert H. Koyle, Asst. Chief Electrician and Henry J. Sieloff, Chief Electrician, standing by one of the giant lead pots used in the plant of The Detroit News.

**Excessive heating of ordinary fuses caused 3 to 4 fuses to open every week. Cooler operation of Fusetron dual-element fuses cured trouble completely**

"Prior to May 20, 1950, we had a bad time keeping all the electric heating circuits on our lead pots in full operation.

"We have two eight-ton lead pots and one six-ton. Each is electrically heated by single phase, 220 volt, 10 kilowatt elements, fed from a 220 volt, 3 phase source. The circuits on each are protected by sixty 60 ampere and nine 400 ampere, 250 volt fuses.

**FOUND 6 TO 8 FUSES BLOWN**

"To be sure that all heating elements were operating properly, we used to check all 207 fuses about once in two weeks. Generally our maintenance electrician would find six to eight of the 60 ampere fuses open.

"This meant that our melting pots were not operating at full efficiency and in addition to this loss, our fuse maintenance and purchases were greater than they should be.

**WITH FUSETRON FUSES NOT ONE OUTAGE**

"As an experiment, we changed all fuses over to FUSETRON dual-element fuses of the same amperages as had been previously used.

"To date, March 9, 1951, or after about nine months of using Fusetron fuses, our records show that not one of them has failed.

"We attribute this remarkable result to the lower resistance of Fusetron fuses which allows them to operate at a cooler temperature than other fuses that we have used."

*Henry Sieloff*, Chief Electrician
The Detroit News, Detroit, Mich.

# Fuses that Protect in 10 Ways now Available

## Fusetron dual-element fuses offer user surprising advantages

1 *Protect against short circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

*Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

### Details on the Fusetron dual-element Fuse

A fuse link combined with a thermal cut-out — the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses, FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

Fusetron is a trade mark of Bussmann Mfg. Co.

### Don't risk losses in your plant!

One **needless** shut-down,
One **lost** motor,
One **destroyed** panel or switch,
One **burned out** solenoid . . .
May cost you more than replacing every ordinary fuse with a FUSETRON dual-element fuse.

**Bussmann Mfg. Co.,**
University at Jefferson, St. Louis 7, Mo.
(Division of McGraw Electric Co.)

Please send me complete facts about FUSETRON dual-element Fuses.

Name.....

Title.....

Company.....

Address.....

City.....State.....951

# today piping repairs cost more!

Crane No. 465½
Iron Body Gate Valve

**You make fewer of them by using Dependable Quality**

## CRANE VALVES

*...That's why more Crane Valves are used than any other make*

**No bonnet joint trouble with this valve**

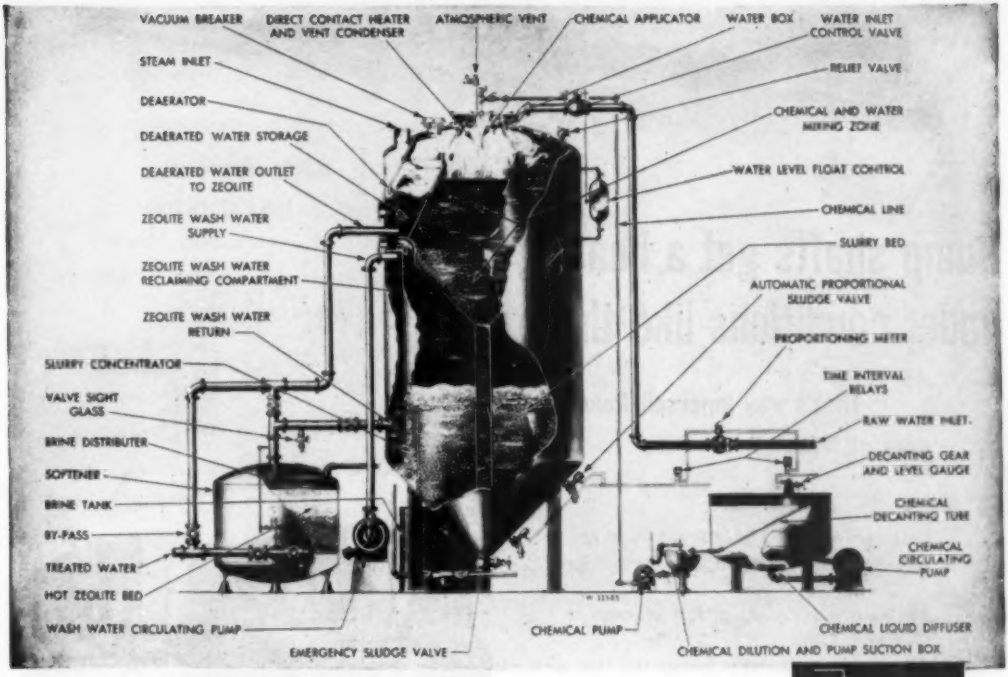
A typical example of low-cost maintenance—Crane No. 465½ 125-Pound Iron Body Gates. Rarely does the bonnet joint need attention. Flange construction includes reinforcement to prevent distortion and utilizes more bolts, more closely spaced, than is usual in valves of this class. Crane precision-guided seating reduces seat and disc wear. Packing has long life because these valves have a deep stuffing box filled with high grade asbestos ring packing. A ball-type gland helps to equalize the packing load.

**Better performance features like these make Crane the better buy in valves of every type. They assure low maintenance cost—low ultimate valve cost—for every piping service.**

# CRANE CO.

*General Offices:*
836 S. Michigan Ave., Chicago 5, Ill.
*Branches and Wholesalers Serving All Industrial Areas*

**VALVES • FITTINGS • PIPE • PLUMBING • HEATING**




# Here's how to make water softening a soft job for you

You have less to do . . . to worry about . . . to pay for—when you use Worthington's revolutionary Hot-Z Slurry-Type Deaerating Water Softener.

It combines all the best features of Hot Process and Zeolite, plus these Worthington-originated features:

*No more scaling trouble.* Direct-contact vent condenser eliminates scaling trouble experienced with old-fashioned shell-and-tube types.

*Supervision reduced.* Concentrated sludge is removed automatically and proportionately to water volume.

*Assures uniformity.* Hydraulic chemical mixer assures uniformity of chemical strength. Also saves space.

*Easier cleaning* of valve-type wash water sight glass.

*Better deaeration.* Steam-jet deaeration is simpler, gives better efficiency—removes oxygen to .005 cc per litre.

*Independent backwash system.* Built-in annular wash water compartment provides clear hot water for backwashing and reclaims it without affecting operating velocities in treating zone. This feature not only pays off in systems employing filters, but also is ideal for backwashing the hot zeolite.

You also save because Worthington Hot-Z Systems operate on low-priced lime and salt. The average installation saves enough in chemical costs to pay for itself in 3 years!

**Get all the facts!**

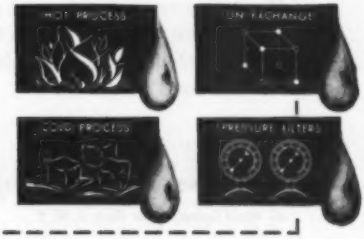
It will pay you to investigate the Worthington Hot-Z System thoroughly. Tell us your conditions of service and get our recommendation in terms of dollars and benefits. You'll find *there's more worth in Worthington.* Worthington Pump and Machinery Corporation, Water Treating Section, Dunnellen, N. J.

J.1.2

**WORTHINGTON**

**WATER CONDITIONING**

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



# Pump shafts get a beating under conditions like these

## That's why Ingersoll-Rand uses "K" Monel

**BOILER FEED PUMPS**
**AT THE PHILIP SPORN PLANT**
**(American Gas and Electric System)**

| | |
|---|---|
| Dynamic Head | 6,000 ft., 2,400 psi |
| Gals. per minute | 1,100 |
| Service | Continuous, pumping deaerated distilled water |
| Length of Shaft | 99½" to bearings |

Boiler units of the Philip Sporn Plant are served by Ingersoll-Rand "double case" pumps.

*Their shafts are made of "K"® Monel.*

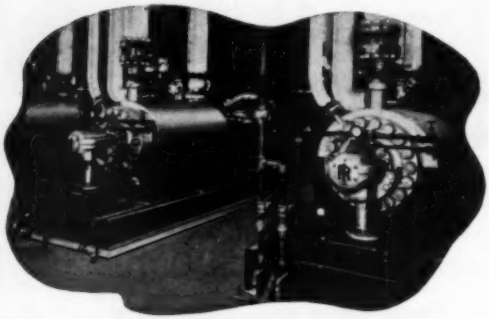
Of course, "K" Monel is ***strong***. But that isn't the only reason I-R used it. Nor is it because "K" Monel is ***corrosion-resistant***. Or because it has unusually high ***resistance to corrosion-erosion and galling***.

What is the reason then?

Actually, a unique combination of *all* these properties. A combination that provides you with long-life dependable pumps for the most severe operating conditions.

"K" Monel's machinability offers other advantages, too. That's because it can be machined in its as-forged condition... and then heat-treated for extra hardness without danger of excessive warpage. After this, "K" Monel requires only finish grinding.

If you are concerned with pump purchasing or maintenance, it will pay you to keep "K" Monel in mind, even though defense demands for "K" Monel are critical.



Each pump at the Philip Sporn Plant is driven by a 2000 hp, 3570 rpm, 2300v induction motor.

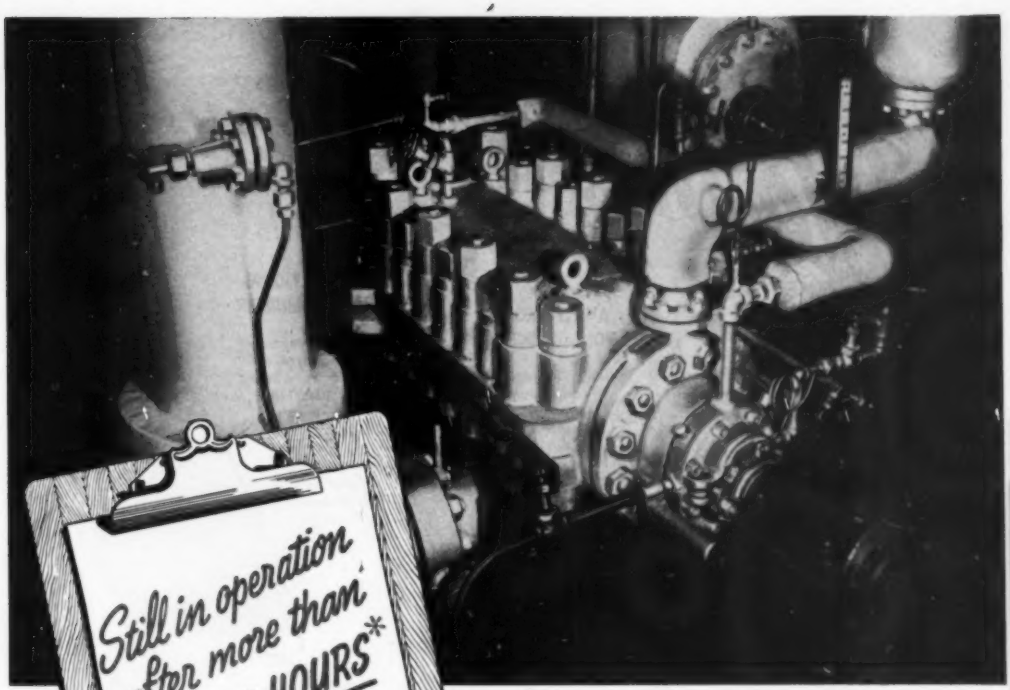
*Write for your copy of this valuable bulletin*

Technical bulletin, T-9, "The Engineering Properties of 'K' Monel," is yours for the asking. It contains data on the composition, mechanical properties and physical constants of heat-treatable, non-magnetic "K" Monel; working properties, corrosion resistance, instructions for heat treatment to obtain high strength and hardness.

**The International Nickel Company, Inc.**
67 Wall Street, New York 5, N. Y.

**Nickel Alloys**

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL
DURANICKEL® • INCONEL® • INCONEL "X"®




THIS INGERSOLL-RAND Class HT pump No. 7C was installed in 1938 in the Windsor Station. Windsor Station is owned jointly by The Ohio Power Company (American Gas and Electric System) and the West Penn Power Company. Since that time the pump has chalked up a service record of 82,659* hours of operation — pumping rated capacity of 1025 gpm to approximately 1900 psi discharge pressure from suction conditions of 415 psi and 380° F.

It has never been opened for inspection.

This is one of six I-R high-pressure boiler-feed pumps at the Windsor Station. The others are giving fine performance also. Four of these were installed in 1941. Here are their records*:

| | |
|---|---|
| Pump No. 7D | 60,277 Hours |
| Pump No. 8A | 53,880 Hours |
| Pump No. 8B | 56,357 Hours |
| Pump No. 8C | 65,063 Hours |
| Pump No. 8D | 37,049 Hours |

* *Hours of operation up to October 1, 1950*

## Here's why performance records like this are routine for I-R boiler-feed pumps

This kind of *dependability* doesn't "just happen"!

It's the end result of the extra care and precision, and the many years of experience that go into every step of Ingersoll-Rand pump manufacture — from selection of raw materials to final acceptance tests.

And it's here — on the job in leading power plants throughout the Nation — that I-R boiler-feed pumps have repeatedly proved their superiority for continuous, trouble-free, high-pressure service.

Whatever your boiler-feed application, there's an Ingersoll-Rand pump that's *right* for the job — a pump you can install with complete confidence in its sustained, high-efficiency performance. Your nearest I-R representative will be glad to give you complete information.

COMPRESSORS • AIR AND ELECTRIC TOOLS • ROCK DRILLS • TURBO BLOWERS
CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

**Ingersoll-Rand**
CAMERON PUMP DIVISION 569-10
11 BROADWAY, NEW YORK 4, N. Y.

# triple-threat to trouble!

**A PROBE TYPE VACUUM TUBE VOLTMETER**

As an a-c probe type vacuum tube voltmeter, ranges of 3 to 300 volts, frequency coverage extends from 30 cycles to 300 megacycles. Specially designed RF and D-C probes supplied.

**AN ELECTRONIC VOLT-OHMMETER**

Using 115 volts, 60 cycle external power, Model 769 is a stable electronic instrument providing 6 ranges from 3 to 1200 volts d-c full scale and 6 ohmmeter ranges to 2000 megohms full scale.

**A VOLT-OHM-MILLIAMMETER**

With self-contained power source, provides 6 d-c voltage ranges (10,000 ohms per volt)—6 a-c rectifier type voltage ranges (1,000 ohms per volt)—6 d-c current ranges and 3 ohmmeter ranges.

## WESTON model 769

### ULTRA HIGH FREQUENCY ELECTRONIC ANALYZER

Here is a truly versatile, three-in-one instrument that's a natural for those engaged in electronics production or maintenance. The entire instrument is protected from external RF influences. Its broad range and its complete stability make it ideally suited for AM, FM, and television testing, as well as for many applications in the HF and VHF fields. Uses standard commercial tubes, replaceable without recalibration. Extremely compact, Model 769 provides greater economy, greater convenience, because this one instrument provides for practically all electronic measurements. Literature available . . . WESTON Electrical Instrument Corporation, 605 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and TAGliabue instruments.

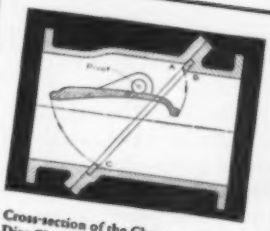
**WESTON** *Instruments*

# CHAPMAN

## TILTING DISC CHECK VALVES

# Cut Maintenance Costs

## with Cushioned-Closing

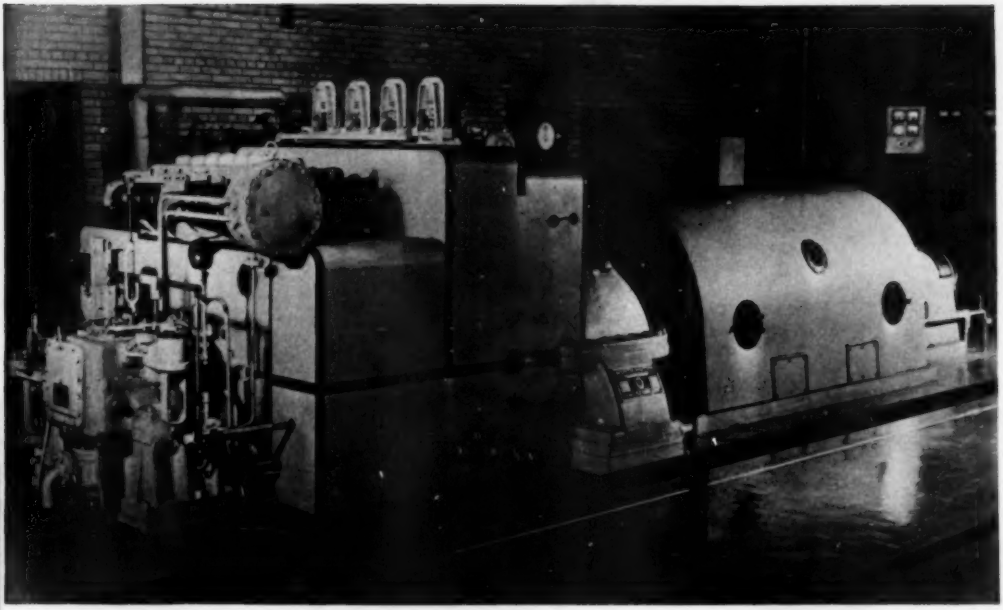


Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

There's less wear on seating surfaces, hinge pins and bearings with the cushioned closing action in a Chapman Tilting Disc Check Valve. No destructive slamming. No fatiguing flutter. No vibration of pipe lines or adjacent structure — nor danger of opening pipe joints or rupturing pipe lines. Just a quick and quiet closure that cuts maintenance costs.

And what's more, the balanced streamlined discs in Chapman Tilting Disc Check Valves ride smoothly on the stream—reduce head losses 65 to 80% over conventional swing type checks. You'll want to know more about this maintenance-saving, more efficient check valve. Write today for engineering data, Bulletin #30.

**THE CHAPMAN VALVE MANUFACTURING COMPANY**
**INDIAN ORCHARD, MASSACHUSETTS**



# Story of an Economy Drive

## How the Worthington Steam Turbine Pays Dividends for the City of Litchfield

What happened at Litchfield, Minnesota, is a clue to a most economical power plant operation.

Originally, the Litchfield municipal power plant consisted of low-pressure boilers, a steam engine and a small turbine-generator unit. The exhaust steam is sold for municipal heating.

Next—a Diesel engine-driven generator was installed. The load grew, and finally, after a careful survey, it was decided to install a 3000-kw Worthington turbine generator and automatically extract steam for heating purposes.

Worthington builds steam turbines in all types and sizes—and turbine-generator sets up to 10,000-kw. For proof *there's more worth in Worthington*, call our nearest office or write to Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.

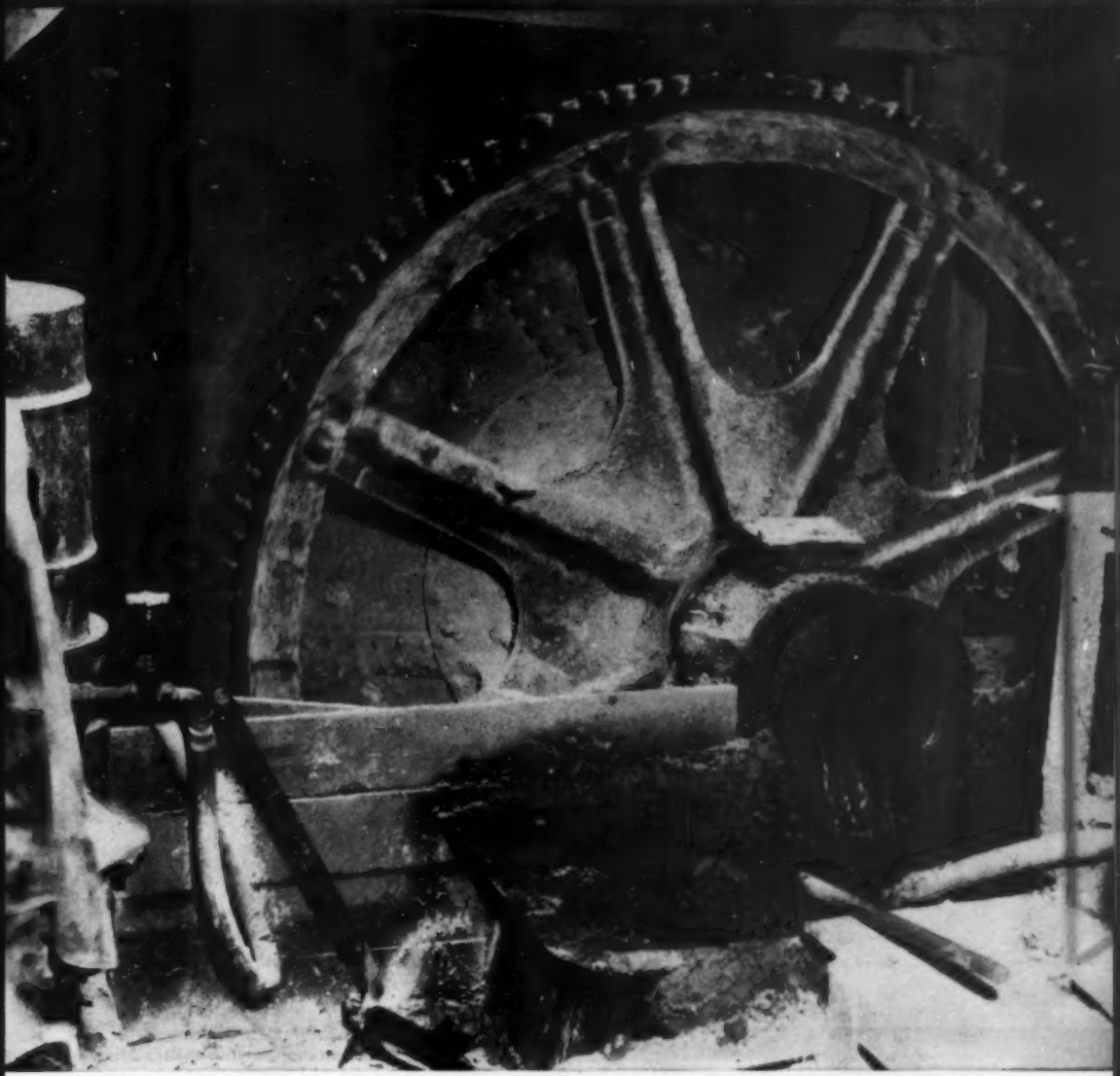
**WORTHINGTON**

STEAM TURBINE GENERATORS

T.1.9

A GREAT TEAM IN STEAM

**B.F.Goodrich** **GROMMET BELTS AT WORK**



*Hundreds of steel balls roll inside this steel drum, grinding up rock and ore to make a white powder used in paints.*

# Rubber muscles spin 25 tons

Inside that big iron drum are 4-inch steel balls—20 tons of them. As the drum turns, the balls tumble onto the ore, grinding it into a fine white powder used in paints.

But there was constant trouble and expense with the big V belts that turn the drum. There was only enough space for six belts, but the job was too big for six ordinary belts. They lasted only five or six weeks. Something had to be done because belt costs were much too high. See how this problem was solved on the following pages.

# Rubber muscles (continued)

*The rubber muscles that drive the big ball mill shown on the preceding page must stand hard pulls and jerks, yet be flexible.*

Here are the belts that save $100 a month on this one drive at Paga Mining Co., Cartersville, Georgia. They look the same as ordinary V belts, but they are B. F. Goodrich grommet belts. They are built on entirely different construction principles, carry heavier loads, withstand more shocks and last longer than ordinary belts. Here is why:

### *20 to 50% Longer Life*

Patented grommet belts by B. F. Goodrich represent the only basic improvement since invention of the V belt. Belts last 20 to 50 percent longer, depending on service. (The more severe

the service the greater the increase over ordinary belts.)

### *What is a Grommet?*

A grommet is like a giant cable except that it's *endless*—a cord loop built up by winding heavy cord on itself. There is no overlapping cord *section* as in all ordinary belts. Most belt failures occur in these sections where cords overlap!

### *All Cords Put to Work*

Each grommet and every part of a grommet carries its share of the load. In ordinary belts under high tension the center cords "dish" because tension is greater near the driving faces. Dished cords are doing less work, not pulling their share. Grommet belts have no center cords, there is no dishing—therefore much more strength in proportion to cord volume.

### *Better Grip, Less Slip*

Grommet belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip pulleys better. Size for size, grommet belts give ⅓ more gripping power, pull heavier loads with a higher safety factor. Because there is less slip there is also less surface wear.

### *They Cost No More*

You save belt costs because belts last longer, save production costs because machines keep running with fewer interruptions, save maintenance costs because they need less attention, yet cost not one cent more than others. Grommet belts are made in C, D and E sections. They are patented by B. F. Goodrich. No other V belt is a grommet belt (U. S. Patent Number 2,233,294).

### *See "X-ray" belt*

A special demonstrator "X-ray" belt has been made to show the grommet construction. Ask your local B. F. Goodrich distributor to show it to you.

# Other belts slipped ➧

This is the main drive of a big rock crusher at Winchester Crushed Stone Co., Winchester, Mass. The V belts formerly used, stretched and slipped because of the heavy impact load. B. F. Goodrich grommet V belts solved the problem. This set has been in service 3 years and is still going strong. Because of this and other experiences, all drives in this plant have been changed to B. F. Goodrich grommet V belts.

*Here BFG grommet belts drive a stone crusher twelve hours a day six days a week.*

# B.F.Goodrich GROMMET BELTS AT WORK

## 3 times better

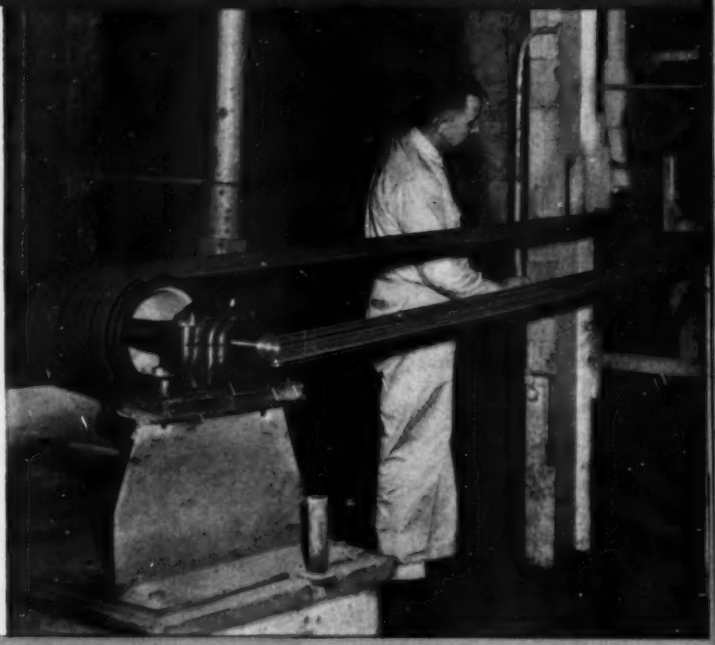
Ordinary V belts on this drive (a big fan for drying grain) lasted 1,674 hours. The company wanted to save money by cutting belt costs so they called in a B. F. Goodrich man and BFG grommet belts were installed. Grommet belts ran 5,153 hours . . . more than three times longer than the former belts. This is a typical example of how B. F. Goodrich grommet belts outlast ordinary belts.

Other users' experiences confirm this:

". . . . ordinary belts would have gone to pieces in a few months . . . . BFG grommet belts have been running for two seasons now."

"B.F.Goodrich grommet belts reduced belt cost 80% plus the time saved in changing belts."

*Belt service tripled by change to B. F. Goodrich grommet belts.* ➔



**These typical examples tell you why B. F. Goodrich grommet belts are superior to ordinary V belts. They prove that grommet belts last 20 to 50% longer—often much more—yet cost no more.**

*Grommet V Belts* BY
**B.F.Goodrich**
FIRST IN RUBBER

*The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio*

*Enthusiastic Users Praise Its Great New Lubrication Savings!*

**From 3 gallons per day to 4 ounces per day!**
A leading pump manufacturer* announces this saving after installing Oil-Mist on a single machine.

# ALEMITE OIL-MIST AUTOMATIC LUBRICATION SYSTEM

**From 3½ gallons to 6 ounces per 24 hours!**
This is the oil reduction on two multi-drilling machines reported by a nationally famous motor car manufacturer*.

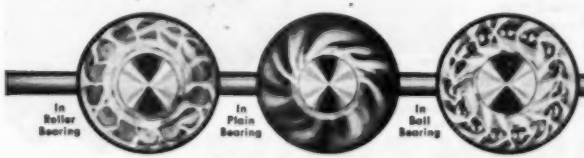
**From 1 gallon per day to 2½ ounces per day!**
The amazing decrease in oil consumption of a well-known metalworking company*.

**From 100 ounces in 8 hours to 5 ounces in 8 hours!**
So reports a prominent tire and rubber company* after installing Oil-Mist on a single sole trimmer.

## The Most Sensational Time, Money and Labor Saving Development in Lubrication History

**Fully automatic, unbelievably simple . . . Alemite's revolutionary Oil-Mist Lubrication System *atomizes* oil into mist, distributes it through tubing to bearings. Bathes *all* bearing surfaces with fresh, clean, cool oil film. Uniformly maintains oil film on all sliding, rubbing, rolling parts regardless of variations in load, temperature or speed. No "peaks and valleys" of lubrication.**

**Proved in use by all segments of U. S. Industry—automotive, aircraft, printing, packaging, canning, appliance manufacturers, metal processors and fabricators, food processors of every sort—Alemite Oil-Mist assures new savings, big savings . . . *savings never possible before* in machinery lubrication! Get the proof yourself through a Desk-Top Demonstration. Clip and mail coupon below *today!*** *Name on request




← OIL MIST

## No Other Lubrication System Made Provides All This!

- Continuous lubrication—to all bearings simultaneously.
- Automatic control, permitting each individual machine to receive proper lubrication whenever in use.
- Elimination of guesswork. The bearing picks up only as much oil mist as it needs.
- Reduced Oil Consumption—Up to 90% in some cases.
- Positive Seal against dirt and abrasives.
- Reduced Bearing Temperatures.
- Prolonged bearing life—as much as 17½ times.
- Prevention of product spoilage.
- Substantial reduction in the number of oils needed.

**Alemite OIL-MIST Lubrication**

**Oil Mist DESK-TOP DEMONSTRATION. No Obligation—Mail this coupon now.** A trained Alemite Lubrication Engineer will give a Desk-Top Demonstration at your office, no obligation.

**Alemite, Division of Stewart-Warner, Dept. M-91**
**1850 Diversey Parkway, Chicago 14, Illinois**

☐ Please have your Alemite Lubrication Representative arrange a desk-top demonstration of Oil-Mist. This entails no cost or obligation on my part.

☐ Please send me information about Oil-Mist by mail.

**My name** _____

**Position** _____

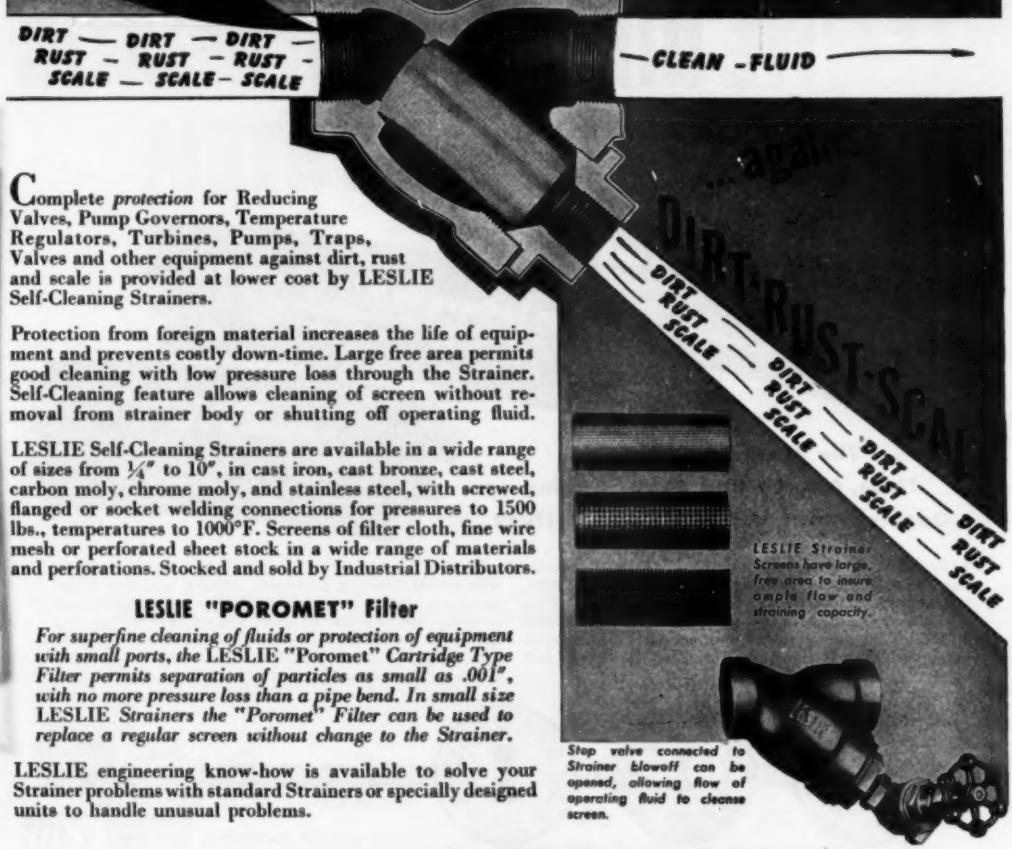
**Company (leave blank if letterhead attached)** _____

_____

# Your Best PROTECTION...

TRADE LESLIE MARK

## SELF-CLEANING STRAINERS


DIRT — DIRT — DIRT —
RUST — RUST — RUST —
SCALE — SCALE — SCALE
CLEAN FLUID
...again
DIRT-RUST-SCALE
DIRT RUST SCALE
LESLIE Strainer Screens have large, free area to insure ample flow and straining capacity.
Stop valve connected to Strainer blowoff can be opened, allowing flow of operating fluid to cleanse screen.

Complete *protection* for Reducing Valves, Pump Governors, Temperature Regulators, Turbines, Pumps, Traps, Valves and other equipment against dirt, rust and scale is provided at lower cost by LESLIE Self-Cleaning Strainers.

Protection from foreign material increases the life of equipment and prevents costly down-time. Large free area permits good cleaning with low pressure loss through the Strainer. Self-Cleaning feature allows cleaning of screen without removal from strainer body or shutting off operating fluid.

LESLIE Self-Cleaning Strainers are available in a wide range of sizes from ¼" to 10", in cast iron, cast bronze, cast steel, carbon moly, chrome moly, and stainless steel, with screwed, flanged or socket welding connections for pressures to 1500 lbs., temperatures to 1000°F. Screens of filter cloth, fine wire mesh or perforated sheet stock in a wide range of materials and perforations. Stocked and sold by Industrial Distributors.

### LESLIE "POROMET" Filter

*For superfine cleaning of fluids or protection of equipment with small ports, the* LESLIE "Poromet" *Cartridge Type Filter permits separation of particles as small as .001", with no more pressure loss than a pipe bend. In small size* LESLIE *Strainers the "Poromet" Filter can be used to replace a regular screen without change to the Strainer.*

LESLIE engineering know-how is available to solve your Strainer problems with standard Strainers or specially designed units to handle unusual problems.

**Look for LESLIE REGULATORS under "Valves" or "Regulators" in your classified telephone directory in the following cities where LESLIE factory trained engineers are located:**

Albany, N. Y.
Albuquerque, N. M.
Atlanta, Ga.
Baltimore, Md.
Beaumont, Texas
Birmingham, Ala.
Boston, Mass.
Bridgeport, Conn.
Buffalo, N. Y.
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Dallas, Texas
Denver, Colo.
Des Moines, Ia.
Detroit, Mich.
Duluth, Minn.
El Paso, Texas
Greensboro, N. C.
Greenville, S. C.
Houston, Texas
Kansas City, Mo.
Kingsport, Tenn.
Los Angeles, Cal.
Louisville, Ky.
Memphis, Tenn.
Miami Springs, Fla.
Milwaukee, Wis.
Minneapolis, Minn.
Mobile, Ala.
New Orleans, La.
New York, N. Y.
Orlando, Fla.
Philadelphia, Pa.
Pittsburgh, Pa.
Ponca City, Okla.
Providence, R. I.
Richmond, Va.
Rochester, N. Y.
Rutherford, N. J.
Salt Lake City, Utah
San Francisco, Cal.
Seattle, Wash.
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Tarrytown, N. Y.
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Montreal, Que., Can.
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Vancouver, B.C., Can.
Bruxelles-Forest, Belgium

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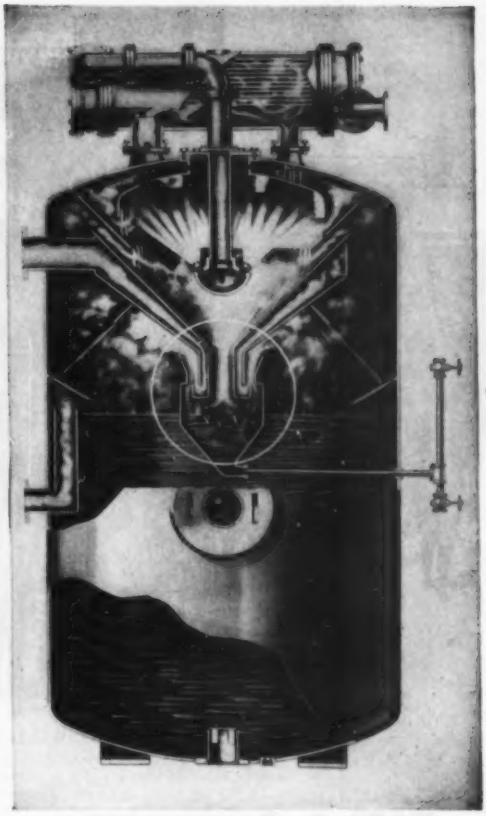
FLOATLESS LEVEL CONTROLS • PRESSURE REDUCING VALVES • PRESSURE CONTROLLERS
SELF CLEANING STRAINERS • PUMP GOVERNORS • TEMPERATURE REGULATORS
• AIR HORNS • STEAM WHISTLES



Hard scale, formed on the trays of deaerating evaporator preheaters, is no longer the big problem it used to be.

In a large central station (name on request), the preheaters had to be cleaned every three weeks, and the units were completely shut down at that time from eight to ten hours.

Then Worthington steam-jet deaerators were installed—with a "blowdown" head designed by Worthington engineers. This special head allows the operator to remove harmful deposits at regular intervals *while the unit continues in service.* It also provides for simple and speedy acid cleaning of critical parts, when necessary, without even opening an access door or removing any parts from the unit.

**Compare The "Time-Outs"**

The Worthington unit, given a short blowdown once each shift, stays in continuous operation with maximum deaeration for periods of at least 8 months. When the acid treatment is given at the end of that period, the job is finished in under three hours.

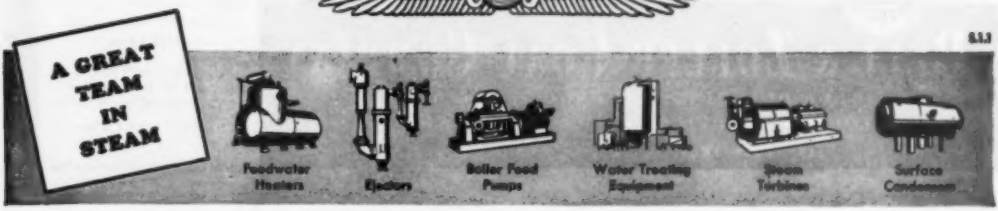
Compare this with the former record. *Then*—8 to 10 hours outage every three weeks and labor by a *crew* of men. Now—with Worthington's blowdown head—operation uninterrupted during regular short blowdown, with a shutdown for acid cleaning only once in almost a year, requiring only one man and three hours!

**Worthington Makes Deaerating Equipment News**

Developments like this, applicable to any deaerators operating under conditions of scaling, are typical of Worthington's engineering firsts in water treating and deaerating equipment.

Worthington manufactures all of the equipment needed in a complete water treating installation. For further information on why *there's more worth in Worthington*, address Worthington Pump and Machinery Corporation, Steam Power Div., Harrison, N. J.

# WORTHINGTON



# Which **one** counts most?

Of all the 2708 men and women who make up Bell & Zoller Coal Company, *no single individual is most important!* Just as in any other business, coal production takes a lot of people doing a lot of different things to keep the ball rolling. And it takes teamwork too. Serving the folks who buy Bell & Zoller coals is a job in which each miner, driller, loader, clerk, salesman and executive plays a vital part. Every one of them—and their families, too—have an important stake in how well the job is done.

Ours isn't exactly a huge organization, nor is it a small one, by any means. But man for man and woman for woman, we don't know of one *anywhere* that does a better job of working together to see that every customer gets the utmost of service and satisfaction.

**BELL & ZOLLER COAL COMPANY**

BELL BUILDING, CHICAGO 1, ILLINOIS

*ST. LOUIS • NASHVILLE • OMAHA • MINNEAPOLIS*

*Sixty-Five Years of Service to Coal Users*

**Producers of**
**ZEIGLER, MOSS HILL, ORIOLE, MURDOCK, JEFFCO, BUCKHORN AND MOUNT OLIVE Coals**

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# WHEREVER YOUR LOCATION...

## YOU ARE ALWAYS CLOSE TO CLEAVER-BROOKS FACTORY-AUTHORIZED SERVICE

CLEAVER-BROOKS steam boiler service facilities are national — to enable you to get the most in performance through proper care and maintenance of your boiler.

**YOU GET...**

**Starting Service:** Boilers are placed in operation by Cleaver-Brooks field representatives who check installation, operation, and make a complete and detailed Field Report to you and to Cleaver-Brooks.

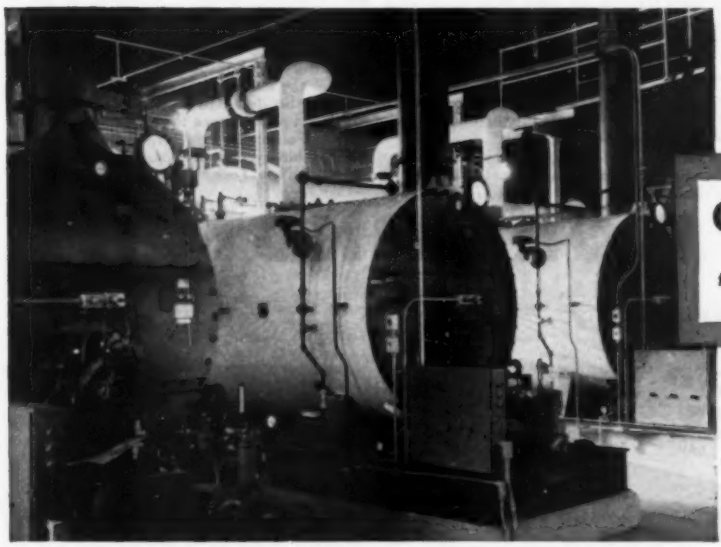
**Operation Manuals:** Your operators are trained in care and operation by Cleaver-Brooks and furnished with comprehensive, easy-to-understand operation manuals.

**YOU HAVE READILY AVAILABLE**

**Parts:** Cleaver-Brooks replacement parts are quickly available through field representatives, parts depots, and the factory.

**YOU WILL FIND IT PAYS...**

to equip with Cleaver-Brooks — steam boilers that operate at a guaranteed efficiency of 80% — burn gas, oil, or combination gas and oil — fully meet all codes — standard models available in sizes 15 to 500 hp.; 15 to 200 PSI.



*Write for latest, fully illustrated and descriptive Cleaver-Brooks Steam Boiler catalog.*

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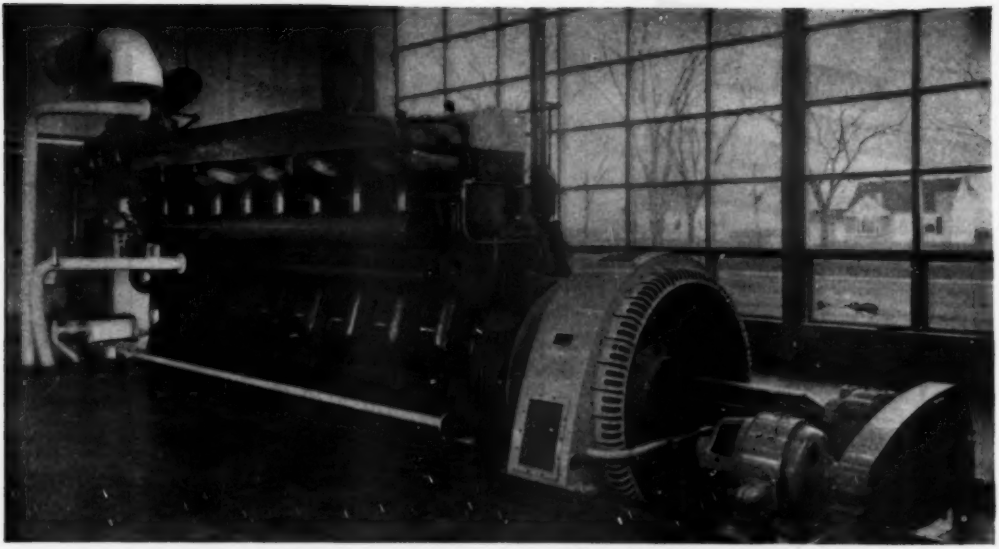
Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners



Typical Worthington supercharged engine-generator unit.

# Makes money when the load is low
# Makes more as the load grows

You take care of the present and future *both* when you put your electric power generation in the hands of a Worthington 4-cycle super-charged Diesel engine.

Records show that such an engine, even when operating at a low load factor, is economical and maintains its economical performance as the load increases through the years.

For example: a Worthington 1500-hp supercharged engine at 40% load produces more kw-hrs per gallon of fuel than a 1000-hp naturally-aspirated engine at 60% load factor.

So it's cheaper to install a 1500 hp-engine today than to install a 1,000 hp-engine today and a 500 hp-engine later.

When you buy a Worthington 4-cycle supercharged engine, you benefit, too, from the longest experience of any manufacturer with this type of engine. For *any* engine application, call on Worthington—an engine for any fuel: oil (crude or regular), gas or "dual fuel". Worthington's complete line of engines assures you of the most economical operation no matter what fuel you use.

If gas or any combination of gas and oil offer fuel economies, consider Worthington gas or dual fuel engines. Only Worthington offers such exclusives as dual plunger pumps, gas micrometering valves for each cylinder, and thermal air controls—all built to give optimum performance for the fuel used.

For further details of the dependable, economical Diesel performance that proves *there's more worth in Worthington*, contact Worthington Pump and Machinery Corporation, Engine Division, Buffalo 5, New York.

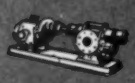
**WORTHINGTON**

E1.3

**ECONOMICAL CONTINUOUS POWER**
Diesel Engines, 150 to 2,640 hp . . .
Gas Engines, 190 to 2,880 hp . . .
Dual Fuel Engines, 345 to 2,640 hp.

WORTHINGTON-BUILT AUXILIARIES

Balanced Angle Compressors



Oil Transfer Pumps

Cooling Water Circulating Pumps

Evaporative-Type Engine Water Cooler

## ...and CONSERVE *precious Brass and Copper*

"ECONOMY DE-LAY" Renewable Fuses offer you the opportunity to conserve scarce Brass and Copper and at the same time make a real saving in the cost of your Fuse maintenance.

After your first cost of an "ECONOMY DE-LAY" Renewable Fuse, you pay only a few pennies for an "ECONOMY DE-LAY" Renewal Link to restore the Fuse to its original efficiency after a "blow". This is much cheaper in the long run than any other type of Fuse protection you can buy.

The simplicity and unusually fine mechanical construction of "ECONOMY DE-LAY" Renewable Fuses and Renewal Links make replacement quick, easy and inexpensive.

***With a reputation for Pioneering and Constant Improvement, ECONOMY has always made its Renewable Fuses and Renewal Fuse Links to meet the maximum of all requirements of "The Standard for Fuses".***

Millions of ECONOMY Renewable Fuses have been in service for years, giving low-cost protection to electrical installations. Keep a full stock of "ECONOMY DE-LAY" Renewable Fuses and Renewal Links on hand!

*Ask for the ECONOMY Catalog and Price List.*

**ECONOMY DE-LAY RENEWABLE CARTRIDGE FUSES**

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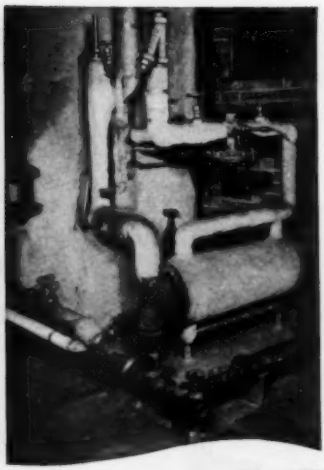
*Your Electrical Wholesaler has "ECONOMY DE-LAY" Renewable Fuses and Renewal Links in stock.*

**ECONOMY FUSE AND MFG. CO.,** 2717 GREENVIEW AVE., CHICAGO 14, ILLINOIS REPRESENTATIVES IN ALL PRINCIPAL CITIES

5041

Sarco type TR-30 regulator with needle valve supplies just the right amount of steam to the oil preheater to maintain correct oil temperature at the burner, regardless of load changes or intermittent operation. Efficient burner operation is assured, resulting in a saving in fuel.



Sarco type 24-30 Temperature Regulator is pilot-operated and single seated for tight shut off when no water is drawn. The thermostat in the water discharge from the heater responds instantly to load changes and holds the water temperature constant — Never too hot or too cold.

# indispensable

## IN ANY POWER HOUSE

In the industrial steam plant of moderate size, elaborate instrumentation usually is out of reach. However, there are two very common applications for which temperature control really is indispensable; namely, fuel oil preheating, and hot water service. Sarco can do the job with inexpensive

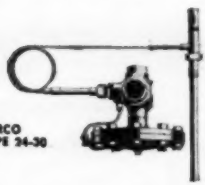
**Self-Operated Temperature Regulators**

which will pay for themselves in a few months — often a few weeks.

SARCO TYPE TR-30

Thousands of installations, as the examples shown, in every part of the country, testify to Sarco dependability. You set them and forget them. Temperatures are always right.

Sarco can solve your control problem within your budget



SARCO TYPE 24-30

Catalog No. 605 lists 12 different styles for heating, cooling and air conditioning; temperatures 0-300°F; valve sizes ¾" to 8". Write for your free copy today.

Sarco

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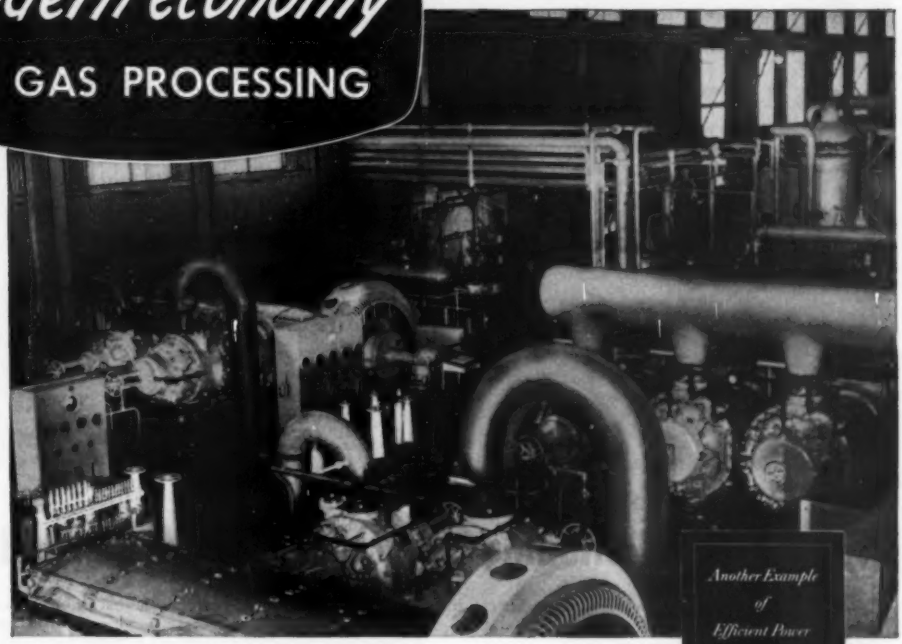
**SARCO COMPANY, INC., EMPIRE STATE BUILDING, NEW YORK 1, N. Y.**

Factory at Bethlehem, Pa. • *Represented in Principal Cities* • Sarco Canada, Ltd., 496 Church Street, Toronto 5, Ontario

# TEAMED UP FOR *modern economy* IN GAS PROCESSING




## *Cooper-Bessemer motor-driven JM compressors*

● These 3 Cooper-Bessemer JM motor-driven compressors are busy saving dollars month in, month out in one of the nation's biggest ammonia producing plants.

If you wonder where the unusual economy comes in, the answer is quite simple. Because these JM's are exceptionally compact, without sacrificing accessibility or ruggedness, they conserve costly space, require less investment in foundations, piping and over-all installation requirements.

Moreover, it's demonstrated time and again that these modern, compact Cooper-Bessemer compressors retain the long life qualities of the much bigger slow speed units. Naturally this adds up to low upkeep cost on any long range basis you care to name.

If your plans call for motor-powered compressor service, up to 3000 hp, let us give you some interesting facts on the Cooper-Bessemer features ready to save you money year in, year out.

*The* **Cooper-Bessemer** *Corporation*

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## Forge . . . Laboratory . . . Cotton Mill . . . Office

# Trane Air Conditioning Serves Everywhere in Industry

Your factory's heating, ventilating or air conditioning problem may not be as tough as you think—not with Trane equipment to handle it.

**In Forge Shops**—A farm machinery manufacturer used Trane Centrifugal Fans in a ventilation system that does double duty in the forge shop. Three big fans on the roof draw smoky hot air out of the shop. In winter, ventilation air, drawn in through floor inlets at the forges, salvages furnace heat to warm the shop.

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***Whatever your heating, cooling, ventilating or air conditioning problem is, look for the answer in the complete Trane line.***

**Cotton Mills**—Trane Heating Coils providing temperatures and humidities that protect delicate threads.

**Factory Offices**—Perfect heating comfort—even right next to the unit—with Trane Convectors that hug walls and save space.

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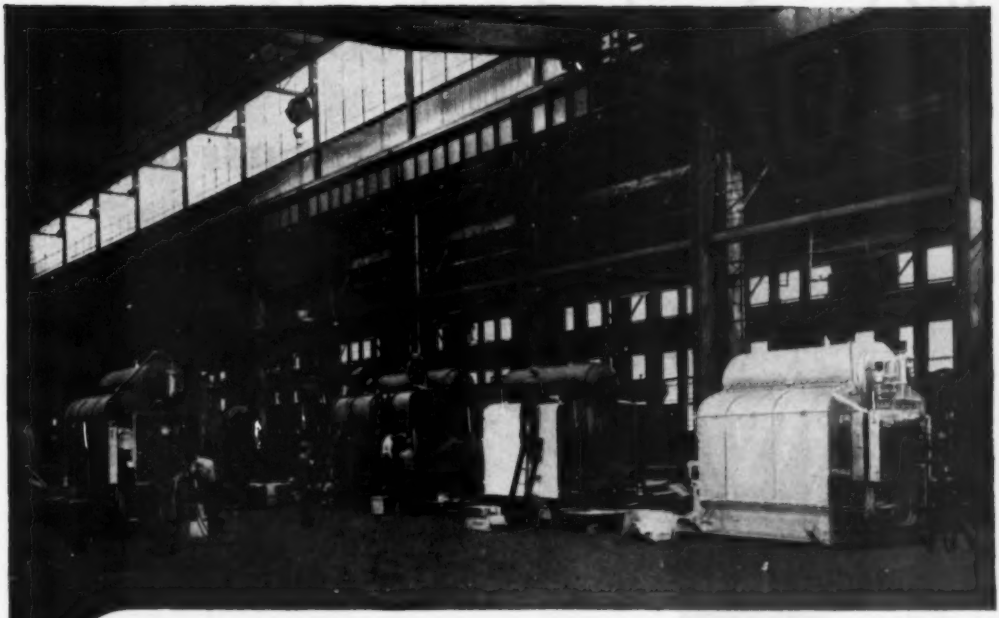

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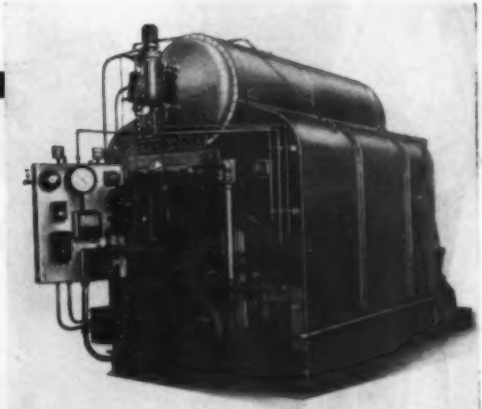
This unique "packaged" boiler design provides quick installation of new steam capacity in the field by simply making the usual service connections. Complete description and dimensions are contained in Bulletin SB-38—yours for the asking.



Typical of the 13 standardized sizes is the above 150 h.p. Erie City Keystone Steam Generator. These are available from 75 to 800 h.p. for pressures from 160 psi.

COMPLETE STEAM POWER PLANT EQUIPMENT

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Complete Steam Generators • Type C 3-Drum Boilers • Types VL & VC 2-Drum Boilers • "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • "Keystone" Packaged Steam Generators • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

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*Your* specific needs determine the exact percentage of fly ash removed by a Research Corporation Cottrell Precipitator.

**LOW DRAFT LOSS**

The pressure drop between inlet and outlet of the Cottrell is extremely low, averaging *only a few tenths of an inch of water.*

**DURABILITY**

Low velocities hold abrasion to a minimum.

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Cottrell precipitators have been used successfully with both small boilers and the very large boilers developed in recent years.

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Available in many **COLORS,** aluminum and white

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"Rigid Economy, Man"

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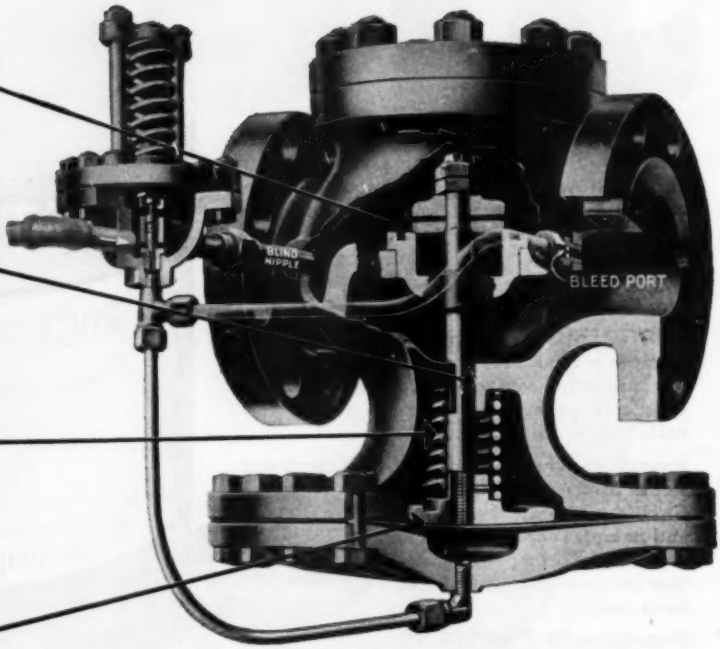
**LARGE BALANCED DIAPHRAGM**—Spence metal diaphragms, under usual conditions, never require replacement. Spence Regulators have few moving parts and those few are ruggedly constructed and seldom require attention.




Spence Type EQ back pressure regulator — operation of main valve is controlled by a sensitive pilot to regulate the initial pressure. Same pilot is used with all sizes of main valves.

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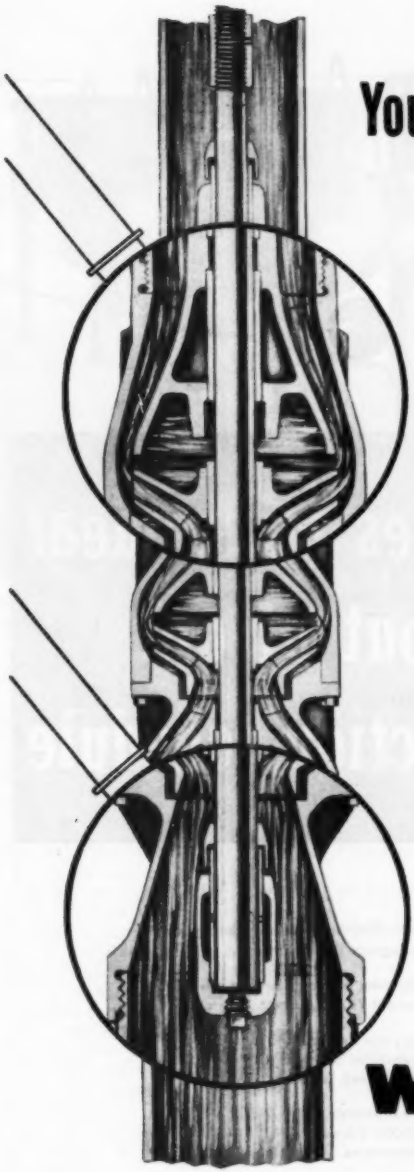

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When you buy a vertical turbine pump, be sure the top and bottom bearings are well protected.

Here's the protection Worthington gives the bearings of *its* pump—better protection than you'll find in any other vertical turbine pump.

*Bottom bearing.* It's grease-packed and won't need attention for the life of the pump. Tests of grease-packed bearing versus rubber bearing show the advantage greatly in favor of the former.

*Top bearing* of oil-lubricated models. Seals above and below the drain ports keep out abrasives which would cause wear and damaging vibration. They also prevent water from entering the tube, which could cause emulsification of the oil and accelerated wear of the line shaft—a Worthington exclusive.

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Worthington Vertical Turbine Pumps are available in sizes from 6 in. up, to handle liquids at temperatures of minus 7F. to 500F., with maximum head per stage over the entire size range.

For other Worthington exclusives—such as flanged and bolted bowls in *all* sizes—write to Vertical Turbine Pump Division, Worthington Pump and Machinery Corporation, Harrison, New Jersey or Denver 16, Colorado.

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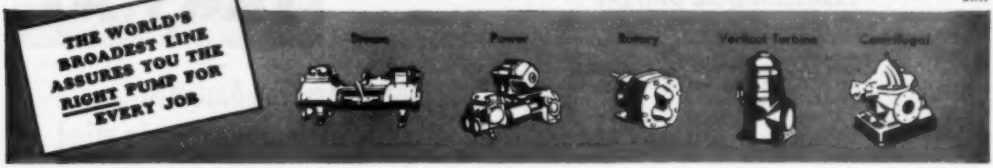

# makes mincemeat out of old production schedule

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A good record? Yes—but not unusual for Yarway. Yarway traps are **designed** to increase production—by sending the most precious B.T.U.'s at top temperatures into your process or product. **They get equipment hotter, sooner . . . and keep it hot.**

Small **size, easy installation,** good for all pressures, dependable operation, low maintenance and low cost are other reasons why over 750,000 Yarway Impulse Steam Traps have already been installed in plants everywhere.

It's **easy** to buy Yarways . . . 216 industrial distributors stock and sell them. One is located near you.

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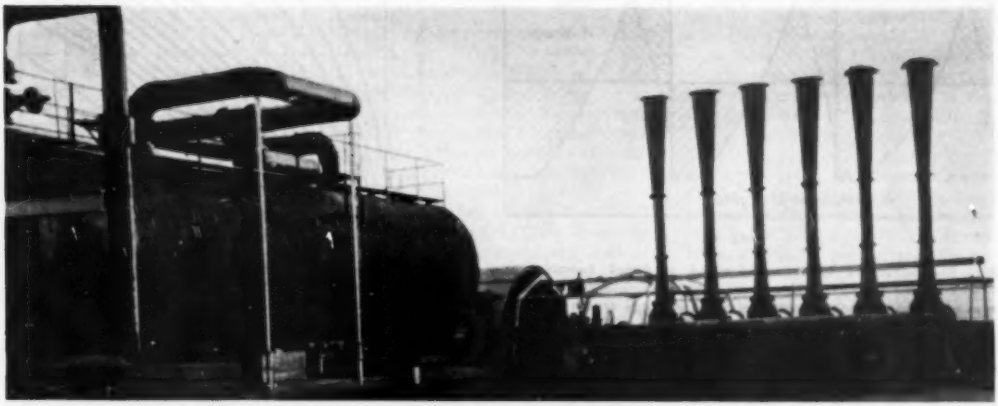
**NEW TRAP SELECTOR**—New 20-page book tells you the right steam trap for any specific application. Write for your free copy.

YARWAY

**the steam trap designed with production in mind**

INDUSTRIAL POWER

September, 1951 Vol. 61, No. 3



*Air ejectors, right, pull vacuum to simulate high altitudes when testing jet engines. For 3 min, 90 psi steam must be supplied at 700,000 lb per hr rate. Accumulator, left, does it from 400 psi 35,000 lb per hr steam supply*

# ACCUMULATORS HANDLE FLUCTUATING STEAM LOADS IN PROCESS PLANTS

**Units are adaptable where cyclic operation of process machinery and equipment causes wide variations in steam demand for short periods. Efficiency of steam generating equipment is improved**

**NORMAN PRICE,** *Design Engineer, Foster Wheeler Corp.*

THE STEAM ACCUMULATOR is an essential piece of equipment in a steam distributing system in which there are intermittent demands for steam in excess of the average output of the boiler plant. It consists of a pressure vessel partially charged with water and suitably designed and controlled so that it may receive, condense, and accordingly store steam during periods of low plant demand and release this steam at a lower pressure during the periods of high demand. Accordingly, the boiler plant may operate at a practically uniform rate with the "swings" in demand taken by the accumulator.

In order that an accumulator may be operative, it is essential that there may be use for steam at some pressure lower than that of the main boiler supply. The amount of steam that it is possible to store in a given volume of water increases with the difference between the supply and the lower pressure at which the steam may be used.

In a steam accumulator, water is heated by direct contact with boiler steam and brought to boiler pressure and saturation temperature, the boiling point increasing with pressure. If steam is withdrawn and pressure is then reduced, thereby lowering the boiling point, part of the water flashes to steam and the water temperature drops to correspond to the boiling point at the reduced pressure. In other words, the sensible heat of the water is converted to latent heat of the steam.

The quantity of steam which may be flashed depends upon the decrease in sensible heat per pound of water, the total weight of water, and the latent heat of evaporation, which varies with the pressure. The quantity of water in the accumulator is variable since it contains more or less condensed steam as the steam is charged to the accumulator or withdrawn from it.

When, in the normal operation of a boiler, there is an increase in load, the pressure drops slightly and additional steam is produced by flashing. The quantity of steam available in this manner is limited since appreciable boiler pressure drop is undesirable. The quantity of water in the boiler imposes another limitation, this being more noticeable in water-tube boilers than in firetube boilers, the latter being known as "steady steamers." In order to satisfy a change in steam demand, the rate of firing must be varied manually or automatically. This is satisfactory if the load does not fluctuate too rapidly to be followed by adjust-

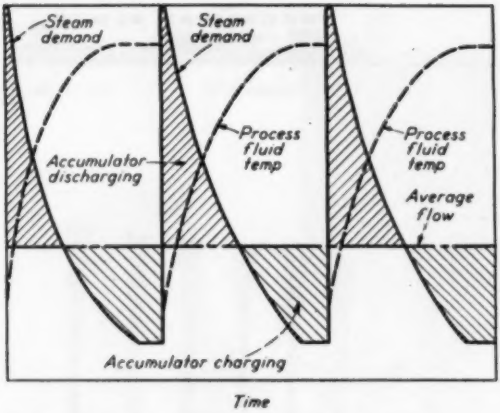



**Fig. 1—Fluctuation in steam demand of batch heaters, as shown here, is met adequately with accumulators. Boilers are operated at constant rate equal to average steam demand**

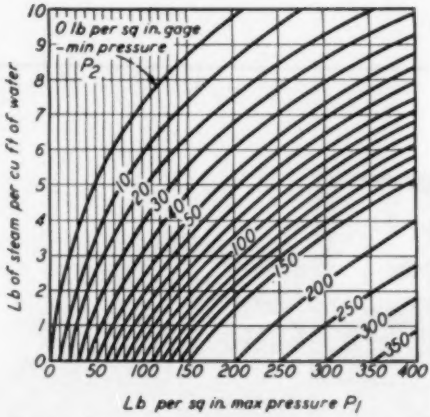



**Fig. 2—Graph utilized for determining quantity of steam per cubic foot of water that may be stored in accumulators to meet fluctuating load demands**

ments of the firing rate and if the maximum demand does not exceed the maximum capacity of the boilers at any time. Rapid variations in firing rate cause increased maintenance costs, decreased boiler life and decreased combustion efficiency. The variation in drum water level caused by fluctuations in boiler load results in increased moisture in the steam going to process or superheater.

Accumulators can be built for as large a storage of steam as necessary and have operating ranges between boiler pressure and process pressure.

The fluctuation in steam demand of batch heaters is shown graphically in Fig. 1. At the start of a cycle, the process fluid is cold resulting in a maximum differential between steam and process fluid temperatures; consequently, steam consumption is a maximum at this point and decreases as the temperature of the process fluid increases.

The boilers should be operated at a constant rate equal to the average steam demand. The upper cross hatched areas of Fig. 1 represent steam supplied by the accumulator during periods of high demand, while the lower cross hatched areas indicate steam to the accumulator when the demand is less than average.

Assuming identical cycles, these areas must be equal and each represents the quantity of steam to be stored.

For small pressure ranges, steam storage capacities may be determined from standard tabulations of the thermodynamic properties of steam.

For the case of an accumulator operating between 120 and 100 psia: the

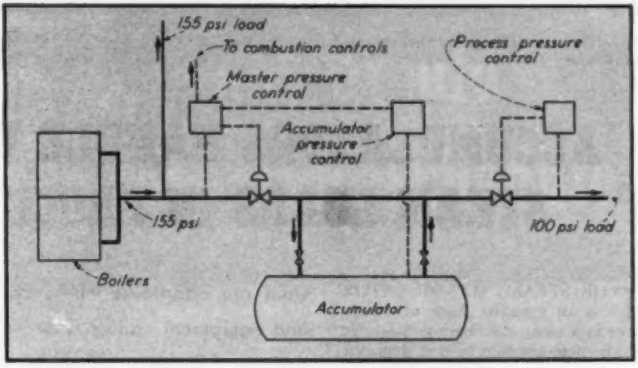



**Fig. 3—Accumulator in steam distribution line at laminated glass plant handles loads varying for 1 min between 80,000 and 8,000 lb per hr rates**

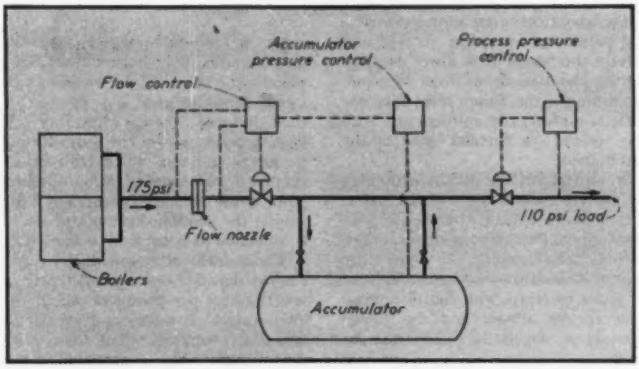



**Fig. 4—Hook-up of accumulator at vulcanized rubber factory where the initial steam load of 60,000 lb per hr drops gradually to 20,000 lb**

enthalpy of saturated water at 120 psia is 312.4 Btu per lb while the enthalpy at 100 psia is 298.4 Btu per lb. The difference of 14.0 Btu per lb is used in the generation of steam by flashing. Since the average latent heat of evaporation in this range is 883 Btu per lb, the weight of steam flashed per pound of water equals 14.0/883 or 0.0158 lb. Saturated water at 120 psia has a specific volume of 0.0179 cu ft per lb giving 0.89 lb of steam available per cu ft of water. If the steam storage requirement and per cent filling (usually 90 per cent maximum) are known, the accumulator volume may be determined. For large pressure ranges in which the quantity of water in the accumulator and the latent heat vary considerably, the quantity of steam that can be stored per cubic foot of water may be determined from Fig. 2.

Fluctuating loads which require accumulators are usually found in batch processes. Examples are discussed in the following sections of this article.

## Laminated Safety Glass

In one plant, safety glass is heated in an autoclave by direct contact with oil. The oil, in turn, is heated by steam in an external tubular type heat exchanger and circulated through the autoclave. Steam is supplied to the heaters at boiler pressure which is 150 to 155 psig.

At the start of a heating cycle, one heater requires 40,000 lb per hr of steam for about 1 min. This rate then steadily decreases for the remainder of the cycle so that the average steam consumption of the heaters for three autoclaves is only 8,000 lb per hr.

This plant has a relatively constant 100 psig load of 107,000 lb per hr giving a total average boiler load of 115,000 lb per hr.

Without an accumulator the boiler output would have to be increased by 40,000 lb per hr almost instantaneously at the start of a heating cycle. If the heating cycles of two autoclaves overlapped, the boiler load would be increased by 80,000 lb per hr. These fluctuations would be extremely severe and undesirable.

The use of an accumulator now permits the operation of these boilers at a relatively constant output.

As shown in Fig. 3, a back pressure controller maintains 150 to 155 psig on the boilers and on the line to the autoclave heaters. The accumulator is charged when the heaters are off. When the autoclave cycle starts and steam is required, boiler pressure momentarily drops slightly and the back pressure control valve throttles the flow to the 100 psig line. The heater takes 40,000 lb per hr and the remainder, which is 115,000 minus 40,000 or 75,000 lb per hr, goes to the 100 psig line. The deficiency in 100 psig steam is made up by the accumulator. A pressure reducing controller maintains constant pressure in the 100 psig line.

If the accumulator approaches either a fully charged or fully discharged condition, as noted by the accumulator pressure approaching either boiler pressure or process pressure, additional instruments reset the firing rate as established by the combustion controls.

In addition to the previously mentioned advantages of constant boiler output, this plant has also found a considerable decrease in the variation of pulverizer temperature.

An accumulator was recently installed in the plant of another glass company having a similar process. Two heaters were used, each requiring a maximum of 54,000 lb per hr of steam at 75 psig for 2 min of a 30 min cycle. This plant is able to operate with one package boiler with a capacity of 17,000 lb per hr at 180 psig. Because of the accumulator, the output is substantially constant. Without an accumulator, boilers of 54,000 lb per hr capacity would be required with the load varying from a maximum to zero during each cycle.

## Vulcanization of Rubber

In the vulcanization of rubber at one plant, steam at 110 psig is required. Since the rubber is cold when put into the mold, the initial steam rate is about 60,000 lb per hr and this gradually falls off to 20,000 lb per hr. The possibility of two or more vulcanizers starting their heating cycles at the same time can very easily increase this maximum steam requirement.

An accumulator was installed to permit operating the boilers at a constant rate with automatic controls as shown

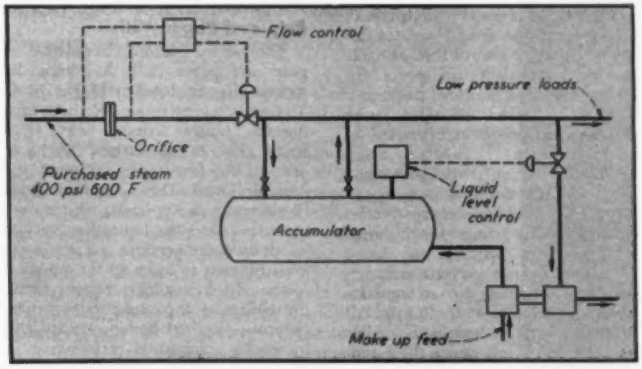



**Fig. 5—Accumulator gets 35,000 lb per hr of 400 psi 600 F steam and for 3 min supplies air ejectors with 90 psi steam at 700,000 lb per hr rate**

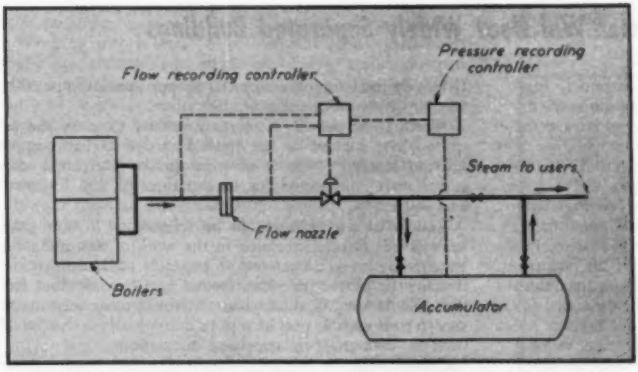



**Fig. 6—Accumulator in steam line at nylon stocking plant handles high rate of 35 psi steam for several seconds followed by 2 min zero demand**

in Fig. 4. Steam flow from the 175 psig boiler is maintained at a fairly constant rate by the use of a flow controller set to pass the average hourly steam requirement. As this average demand varies due to variations in production rate, the accumulator tends to become either fully charged or fully discharged. This condition is detected by a pressure controller which resets the flow controller.

The pressure controller downstream of the accumulator maintains steam to the vulcanizer room at 11 psig.

### Testing of Jet Engines

In the testing of jet engines, high altitude conditions must be simulated. The required vacuum may be obtained by the use of high capacity steam jet air ejectors supplied with steam from an accumulator as shown in the lead illustration on the first page of this article. The ejectors and low pressure turbines require 700,000 lb of steam per hr at 90 psi for 3 min. Steam is purchased from a local power company which is not capable of handling so great an instantaneous demand. Hence, the accumulator must have a capacity of 700,000 lb per hr times 1/20 of an hour or 35,000 lb. The power company supplies 400 psig, 600 F steam at a rate of 35,000 lb per hr thereby permitting one test every hour. When steam is available at a higher rate, tests are run at short intervals.

Since the power company supplies steam at constant pressure and the accumulator pressure varies, flow is maintained substantially constant by using a flow controller, Fig. 5.

Since the ejectors do not require the full capacity of the accumulator, low pressure steam is available for the turbines. To prevent damage to the turbine blades, the moisture content of the steam is decreased by the use of internal steam separators in the accumulator. These separators are of the type used in evaporators.

Since superheated steam is used to charge the accumulator and saturated steam is discharged, more than 1 lb of water is evaporated for each pound of boiler steam condensed. This requires a small quantity of make-up feedwater which in most installations is taken from the boiler feed pump. However, this plant has no boilers (and consequently no feed pumps) so that a small make-up feed pump is driven by steam from the accumulator.

### Accumulator In Nylon Plant

In the manufacture of stockings, nylon is placed over leg shaped forms and subjected to high temperature by direct contact with steam. This permits plastic flow to the desired shape. The temperature is then reduced and the contours of the stockings remain permanently set.

This process requires a high rate of 35 psig steam for several seconds followed by about 2 min of zero demand. One particular plant had severe difficulties with its steam load because of the variations of the individual cycles and the overlapping in operation of several machines.

Although a steam accumulator could store sufficient steam, a pressure reducing valve would not be able to open and close rapidly enough for this service. The unit is operated as shown in Fig. 6 without a pressure reducing valve by restricting the accumulator pressure range from 45 to 40 psig. Although the storage capacity per cubic foot of water is low under these conditions, there is no possibility of exceeding the design pressure of the machine.

Steam from the boilers to the accumulator is controlled by a flow controller set for the average of all machines. The flow controller is reset by an accumulator pressure controller as the accumulator tends to become fully discharged or charged due to variations in the production rate. These variations are particularly noticeable at the start of a shift and also after lunch when several machines are started simultaneously.

### Tobacco Plant

Tobacco is moisturized for ease of handling by subjecting it to several cycles of vacuum followed by low pressure steam. Steam accumulators are usually required in such installations.

Constant flow from the boilers may be maintained by a flow controller and steam pressure to the machines is regulated by a pressure controller. Each machine has its individual steam controller.

### Pulp and Paper Mills

The use of steam accumulators in pulp and paper mills has been described in great detail by D. K. Dean.[1] To briefly review this application, each digestor heater requires very large steam flow at the start of the cycle due to the low temperature of the cooking liquor. This steam flow steadily decreases as the liquor temperature increases. After the liquor has reached its desired temperature, steam is required merely to make up for radiation losses. An accumulator permits firing the boilers at a constant rate thereby reducing required boiler capacity and increasing combustion efficiency.

1. Tappi, April, 1950.

## Extra-Hot Hot Water Will Heat Widely Separated Buildings

• A system for distributing hot water at extremely high temperatures has been designed to heat buildings at the Limestone, Maine, Air Force Base. Water will leave the boiler house at about 225 psi pressure with a temperature of 360 F and will be distributed to approximately 50 buildings through an underground system.

Although widely used in Europe, there are few high temperature hot water distribution systems in the United States. This system, designed for Limestone by Guy B. Panero, Engineers, is believed to be one of the largest in the country.

Two new boilers, each capable of producing a maximum of 83,000 lb per hr of steam at 175 psig are being added for the system. This doubles capacity of the boiler house.

The project will require about 50,000 ft of pipe, varying in diameter from 1 to 12 in. The design work involved original research by D. T. Webster, chief mechanical engineer of the contracting organization in devising a proficient method for obtaining the proper sizes of pipe to be used in the various parts of the system.

Plotting lbs per hr of water necessary to carry the required heat content on the vertical axis of a chart against friction loss per 1000 ft of pipe on the horizontal axis, curves were constructed for temperatures of 200 F, 280 F and 360 F.

Results of the research, to be released at a later date, have saved considerable time in the work of designing the system. By using the curves, an engineer could quickly determine the proper pipe size, from 1 to 12 in., without further calculation. Without them, it would have been necessary to treat each section of piping individually as a separate problem with all of its associated calculations.

Construction on the high temperature hot water system for heating the base is under way. It is expected that it will be completed sometime next fall.

**Strip heaters attached to the screw conveyer made addition of the more costly rotary drier unnecessary. The heaters, shown before insulation was applied, heat coal to 100 F in 1¾ min.**

# RADIANT HEAT FOR COAL PROCESSING

## Strip heaters allow a screw conveyer to do two jobs at once—carry and heat coal—with better temperature control, low cost and small space

**J. A. McINTOSH, *Johnson Coal Cubing Co., Inc.***

COAL PROCESSED in this Michigan plant originally required only one rotary drier for all preparatory heating of both the soft coal being treated for packaging and the mixture of anthracite and bituminous coals for briquettes. The drier, an expensive item, caused a bottleneck because it could not handle both types at the same time.

Increased demand for both forms of coal necessitated a separate screw conveyer to carry the soft coal from its silo to a pug mill where a starch binder is added. The coal must be raised to the 100 F temperature that had been attained in the rotary drier. In the pug mill, temperature is boosted to 185 or 190 F.

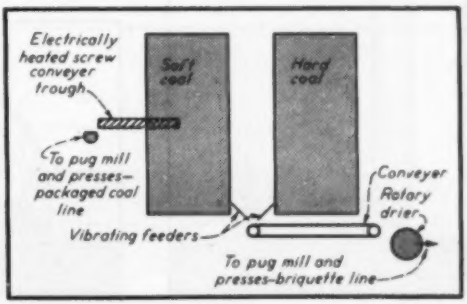
Another rotary drier would have cost $25,000 and required considerable space. Superheating the steam supply to the pug mill was considered but the amount required was prohibitive. Steam jacketing the conveyer would have cost as much as a new drier and taken a year for installation.

Working with a local power company representative, an application engineer advised the use of strip heaters clamped to the screw conveyer as shown in the top photograph. Heating load is divided into three equal sections composed of Chromalox strip heaters, each section having a thermostatic temperature control and contactor. Coal temperature is regulated at the discharge end. Insulation 4 in. thick encloses the conveyer.

Power requirements are 200 kw. The conveyer carries 12 ton per hr of slack and the coal temperature is raised to 100 F in 1 ¾ min.

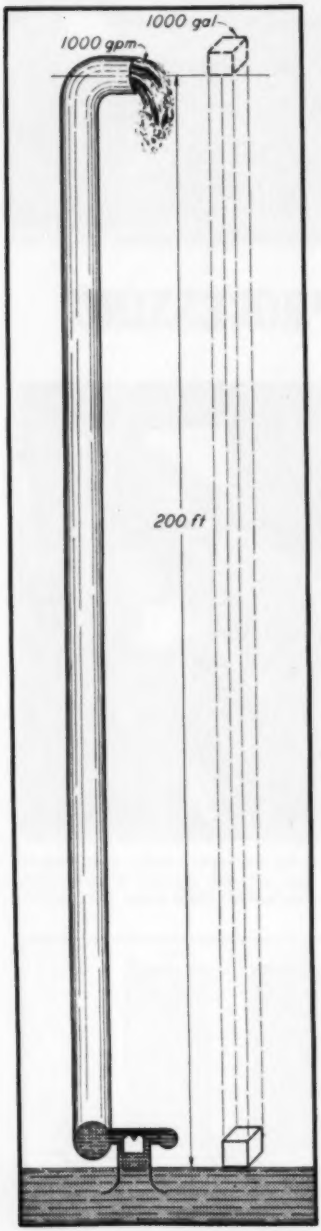
Investment for the strip heaters and controls was about one sixth the cost of a rotary drier. They were installed on existing equipment, required no extra space and were quickly applied, avoiding a long production delay. Starting requires only the use of a switch and the close temperature control avoids many production problems. Strip heaters appear to be the only safe method of getting so much heat into coal carried on a screw conveyer.

**Heated and insulated, the conveyer carries coal from its silo directly to the pug mill and presses. Electric units, fitted to the existing equipment, allow close heat control**




**Heating the soft coal conveyor with radiant units use no additional space. Rotary drier is used on briquet line only**

# PRACTICAL CONSIDERATIONS IN APPLYING




**Intricacies of specific speed, cavitation and submergence, sump design, research with plastic models and handling gaseous liquids are explained. Determining elevation head and head losses are outlined**

**R. H. BIRD, *Designer, Peerless Pump Div., Food Machinery & Chemical Corp.***

AXIAL FLOW PUMP moves water in a nearly true axial direction and was originally done by a rotor having two or three pure helical vanes. The undesirable pressure distribution within this type impeller is largely responsible for the development of modern type, which bases much of the section design on air-foil forms developed by the National Advisory Committee for Aeronautics used in present-day airplane wings and propellers. In contrast to the propeller type of pump is the conventional centrifugal with the radial impeller where the flow is usually perpendicular to the axis of rotation. Combining these two extremes and various amounts of axial and radial flow components produces the so-called mixed flow pump, which has its capacity and head limits between the two. The propeller and mixed-flow pumps have a quantity range in common but are complementary in the range of head characteristics.

When pumps of various sizes, types, speeds and quantities are to be basically compared, use is made of a mathematical yardstick, known as specific speed designated NS. This representative figure is the speed in revolutions per minute at which a geometrically similar impeller would rotate to deliver one unit of quantity against one unit of head or lift.

## Specific Speed

Specific speed range for the mixed-flow and propeller pumps is about 7500 to 15,000. There is no clear-cut lower limit of specific speeds for pumps having a distinct mixture of axial and radial flows, but some mixed-flow is found in the range of 2000 to 3000.

In terms of reduced price, weight and size the specific speed should be highest possible for the selected head and capacity. As the size decreases, the flow velocity is increased. As with any machine, there are restrictions governing its successful and economical operation. Experience indicates that the recommended upper limit of rotative speed is 5000 fpm, which is the vane tip velocity at the maximum diameter.

From strength and balance considerations, much higher speeds are possible, but the practical limits of sumps and other suction systems impose certain restrictions. Nominally, for heads up to 100 ft, the mixed-flow pump can be multi-stage with a slight gain in efficiency. On some occasions in the smaller sizes adaptable to deep wells, lifts of 150 ft have been accommodated.

To accent the need for accuracy in

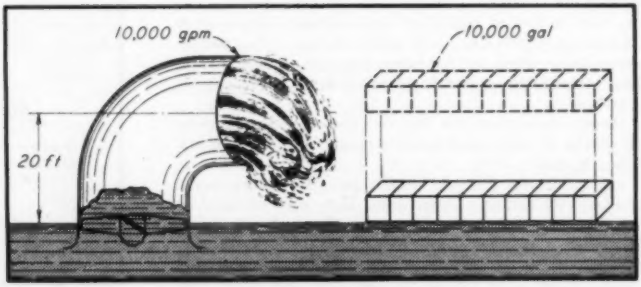



***Fig. 1—Graphic representation of two pumps — one with 200 ft head and 1000 gpm, the other with 20 ft head and 10,000 gpm. Ten foot head drop is permissible in the deep well, while only one foot drop is allowable in the shallow sump***

# AXIAL-FLOW AND MIXED-FLOW PUMPS

measuring head and velocity, consider the following extremes of pumping systems. In the deep well application, compare 1000 gpm at a lift of 200 ft with the usual axial pump application of 10,000 gpm at a lift of 20 ft. A fluctuation of pumping level of 10 ft for the well is the usual factor, but only the weight of 1000 gpm is involved.

However, for the weight of 10,000 gpm, an error or fluctuation of the 20 ft lift of only one foot will be possible for the same energy, Fig. 1. In a practical sense, this comparison should be applied to field testing low-head pumps for suitable accuracy in determining such factors as elevation head, shock and friction losses in bends, special fittings and pipe proper, as well as allowances for velocity head for open pit installations.

### Obtaining Field Data

Surveyor's transit are valuable instruments for accurately finding elevation head, and the differential water manometer can be used to locate unusual losses of head. Pressure measuring devices such as a differential mercury manometer or a calibrated low pressure gage must be properly located with respect to obstructions, which disturb the flow pattern. This is about 10 pipe diameters downstream. In detail, after the hole has been drilled and tapped, the edges must be freed of any burrs or chips, and the pressure tap inserted without projecting into the stream.

Capacity can be found with a calibrated pitot tube and several traverse readings at 90 deg intervals. Although the input horsepower can be obtained with a stop watch and the utility company's meter, two calibrated watt-hour meters with suitable transformers are more accurate, since errors in measuring time and the unbalance of the electrical phases are minimized. Determining the rotative speed of the pump closely is important when comparing field performance with guarantee curve.

### Investigating Cavitation

Subject of cavitation seems to be a growing one with unusual phenomena being revealed as more deliberate studies and experiments are made. The destruction appears to be caused by implosions of vapor bubbles formed during a low pressure phase. Observations made by Weyl, Marboe, Harvey and Audubert have broadened the aspect to include chemical and electrical destruction resulting from molecular dissociation. The metal is thus exposed to simultaneous attack of a strong acid and base as well as the powerful electric discharges. In this ultrasonic field, there is produced a sonoluminescense resulting from the recombination of the broken water molecule. All attempts to give a purely mechanical explanation for this type of corrosion is impossible with present knowledge.

Superficially, the cause of cavitation is lack of sufficient pressure on the suction side of the impeller. In the open pit installation, submergence is the factor along with flow peculiarities. The closed system has other factors, such as abnormal velocity heads, shock and friction losses all of which reduce available atmospheric or tank pressure. Adding to the problem is the condition of hot liquid and elevation above sea level. Actual field experience indicate that the correct adjustment of semi-open mixed-flow impellers contribute much to prevent local cavitation.

Circulation of the leakage stream at the boundary edges of the vanes disturbs flow streams to such an extent that borderline low pressure regions are further unbalanced and cavitation develops. Recommended submergences for the various sizes and speeds will assure safe operation within the head-capacity range, provided the sump is of such design as to suppress vortices and furnish sufficient quantity with uniform low velocity. Intensity of cavitation destruction is a matter of degree and definitely is present below the usual level of sound and vibration when the system is operating on limits that are too close. On this basis pump manufacturers prefer to be more conservative with the recommendations of speed and submergence.

### Sump Considerations

Proper sump design is one of the most important considerations in any successful pumping station, particularly where axial-flow or mixed-flow pumps are installed. All too frequently a sump is regarded as merely a round or square hole in the ground where liquid is allowed to enter in a random manner. Most frequently in such cases the burden of properly handling the liquid is left entirely to the pump. Since the inherent characteristics of pumps are such that the liquid must flow to it in a proper manner and under controlled and rather exacting conditions, there have been numerous cases where failure has actually been the direct or indirect result of improper sump design.

Sump design is neither simple nor exacting. No precise formulae or geometry can be set forth to insure, in every case encountered in the field, a uniform and proper flow of water into

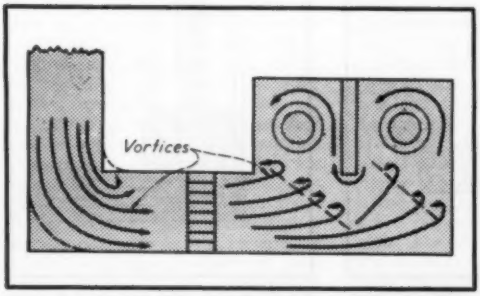
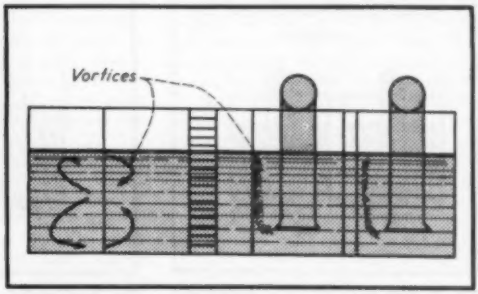



*Fig. 2—Sumps that permit stream bending, whether angle be sharp or medium, cause vortices and uneven velocities*




*Any attempts to suppress vortices at the surface are unsuccessful since whirl has been introduced at the bellmouth*

the pump. Much research work of a practical nature has been done in regard to this subject, and great strides have been made and constructive generalities have been derived.

When the size and expense of a plant warrant, construction of accurate working models is usually advisable to fix the limits by actual tests, and thereby endeavor in advance to eliminate all undesirable characteristics. By observing water flow in actual laboratories, eliminating certain general forms and shapes is frequently possible. Futhermore, certain arrangements in the sump will be revealed as being very desirable for pumping under consideration.

## Plastic Models

At the present time considerable research work is being accomplished with transparent plastic models of various types of sumps. By using a medium such as saturated sawdust in the water, the actual flow into and out of the sump can actually be observed and photographed. Hence by introducing various shapes and forms such as baffle plates and deflectors at various angles, actual observation can determine directly certain desirable combinations and dampening devices.

While many actual sumps have serious design defects, they have been sufficiently observed and classified in the field. Study and appraising these data illustrate how not to design a sump. Correlating this negative aspect with the direct results of model work previously described provides some basic and simple requirements.

Any stream that makes a bend, whether sharp-cornered or with a large radius, will form vortices and give rise to uneven flow velocities about the sump, Fig. 2. The preferred system, Fig. 3, does not introduce whirl and more evenly and uniformly proportions the quantity to the entire suction manifold of the pump. In these sketches, an attempt is made to show some of the outstanding streamlines and some of the critical vortices. Attention is called to the return flow from one sump to another that further aggravates the condition and is most undesirable, Fig. 2.

The circular sump, Fig. 4, with the side inlet at an elevation above the sump bottom is generally quite troublesome. It will cause the pump to sway or vibrate sideways as well as to form regions of whirl. If the side inlet should be lowered to the bottom, and vertical baffles or fins installed, Fig. 5 there will be an improvement.

Quite frequently, an axial-flow or mixed-flow pump installation will require a strainer attached to the suction manifold. This is generally not satisfactory since scale, rust or debris can easily cause an obstruction. A gradual restriction of inlet area can take place that can give rise to serious operational difficulties. The losses will frequently exceed the available submergence head. Therefore, the proper way for separating trash and debris is the movable traveling screen installed some distance from the suction manifold.

Several pumps in the same sump in various combinations is sometimes necessary. This gives rise to a more complicated problem than a single pump. As the flow system varies it should be regulated in accordance with the results of model studies. This will definitely aid in fixing acceptable limits of the capacity range for the different combination of pumps in service.

Axial-flow pumps have the broadest applications where large quantities of liquids are transferred relatively short distances. Some examples of this are in dry dock dewatering, navigational locks such as the Panama Canal, municipal water systems from rivers, lakes and reservoirs for primary water source, industries — steel mills, chemical plants, paper mills, sugar mills, treated sewage transfer and steam turbine cooling water. Many special pumps have been supplied for sump and coffer dam dewatering, raising sunken ships and in combination with the usual deep well pumps handle water, which contains large proportions of gas.

## Gases in Water

Handling of water that contains appreciable gas is a challenge to the astute application engineer and frequently problems of this kind have been solved by using one stage of axial flow pump in connection with the usual turbine type pump. Installing an axial flow impeller in the stage next to the suction manifold and the turbine bowl and impellers is good practice. This idea itself is a rather lengthy and involved one and merits investigation where gassy water is present.

***( Continued on page 109 )***

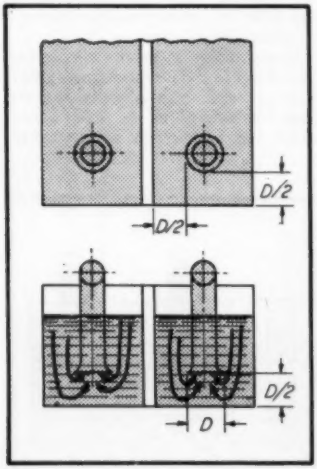



***Fig. 3—This type of sump design will not cause whirling as steam flow to the pump suction is even and uniform***

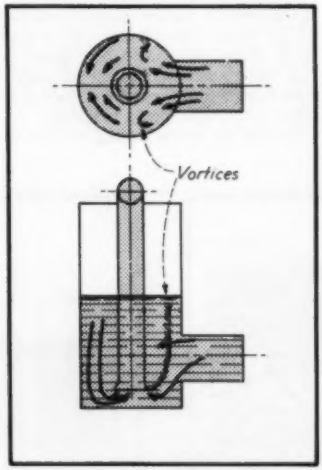



***Fig. 4—Circular sump, with side inlet above sump bottom, can cause pump sway or vibration, producing vortices***

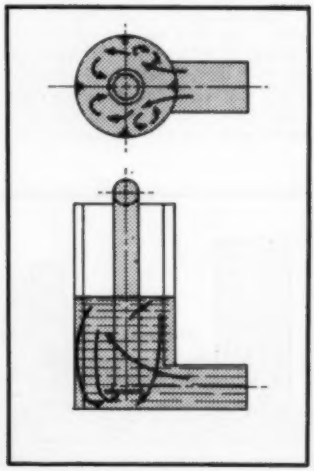
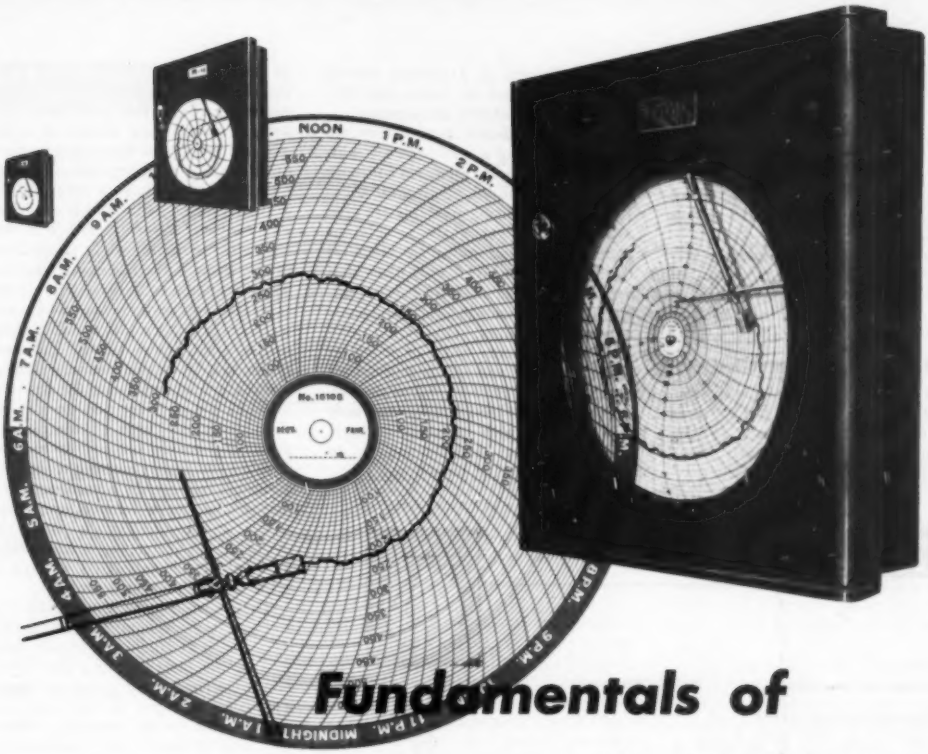


***Fig. 5—If side inlet and sump have a common elevation and baffles are introduced, conditions show improvement***




# Fundamentals of Automatic Control

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**WILLIAM J. HARGEST,** ***Editor, and*** **A. B. WHITE,** ***Associate Editor***

AUTOMATIC CONTROL is an impressive term, but could be aptly applied to a home heating system. The living room thermostat is a simple form which measures room temperature and starts the furnace burner at a few degrees below the thermostat setting. Similarly, an industrial controller may detect temperature in the heating zone of a boiler and regulate fuel supply to maintain this temperature near the desired value.

Underlying principles of automatic control are applicable to many different specific applications. Whether water temperature from a heat exchanger must be regulated for diesel engine cooling service or for washing operations in a textile mill, the basic instruments are the same and selection is based on the same fundamentals.

For the man in some phase of plant engineering, this article presents, in A-B-C language, principles of automatic control providing a comprehensive "speaking acquaintance" with basic terms and concepts. Dividends are (1) a better understanding of individual problems (if only to talk on more equal terms with an instrument engineer) and perhaps (2) a concept of certain benefits which only the individual engineer can realize and may not as yet have capitalized upon.

## Why Automatic Control?

Although the use of industrial controllers for temperature, pressure, flow, and other variables has expanded rapidly in recent years, there are doubtless a number of industries where advantages of automatic control have not been fully exploited and where plant management may desire more concrete evidence of its merits.

In Fig. 1, water is being heated by steam. An operator could observe a stem-type thermometer immersed in water and turn a hand valve on the steam line to control temperature at the desired value. In some simple batch processes, such control proves adequate, but obviously may take nearly the full time of the operator and it is subject to error due to the operator negligence or fatigue. This brings out two important advantages — it frees operators for more productive duties and also eliminates human errors.

Modern industrial instruments can measure deviations of many variables before the operator could detect them on a meter or gage, and control mechanisms are available to continuously initiate corrective actions so that the critical variable is maintained within extremely narrow limits. The result is uniformity of product quality far exceeding that given by hand control.

It is in continuous operations, however, that automatic control can prove invaluable. Where the product of one unit forms the feed to another unit, it may entirely upset operation of the latter by too wide a variation in temperature or other quality. In such cases, steady-state conditions are often difficult to achieve and must be guarded carefully against upsets.

Savings in fuel and raw material consumption are often the paramount

benefits. By more exactly proportioning fuel input or flow of materials to meet requirements, controllers can eliminate waste and spoilage, thereby reducing operating costs.

In summary, automatic control is employed primarily for purposes of efficiency and economy. It is a tireless guardian over numerous operations and will more than pay its own way in savings of fuel and materials, as well as in increased operating efficiency because of greater output or higher quality for the product.

## What Should Be Controlled?

The variables most frequently controlled directly are, logically, those most easily measured — such as temperature, fluid flow, pressure, liquid level, humidity, pH, and specific gravity. Usually, however, regulation of such variables is not an end in itself, but rather is the most practical method of maintaining the desired quality or condition of the final product. In the heat treatment of a steel part, for example, temperature control is used to obtain desired metallurgical properties.

First consideration for automatic control is proper selection of variables to be held constant. They must, of course, bear a close relationship to the conditions to be regulated. The controller will merely translate the variable (such as temperature) that it is designed to measure into a corrective action (such as throttling of fuel to a furnace) and cannot be expected to counteract for changes which it does not detect. Even location is important in this respect, since a temperature sensing element in a furnace, poorly located in a dead air space, does not measure representative temperature.

Modern industrial instruments are continually being adapted for use with new types of sensing elements for more specialized variables. A few of these for which measuring methods are now available are: gas analysis, solution conductivity (and indirectly chemical concentration), high and ultra-high vacuums, smoke density, dewpoint, chemical composition, wall thickness of vessels and pipes, viscosity, turbidity and many others. Since instruments which measure and indicate or record these variables are only minor modifications of basic model, they can easily be supplied with standard control mechanisms for incorporation in an automatic system of regulation.

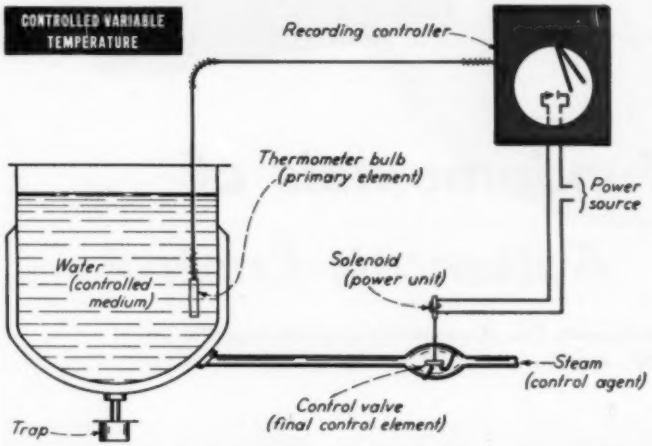



***Fig. 1—In simple processes, operator could watch thermometer, add heat as needed. But automatic control with simplest components would free operator, avoid errors***

## Elements of Control Systems

Any system of automatic controls involves a *process* and an *automatic controller*. Each has important characteristics which affect the controllability of the system.

The process may be defined as "the collective functions performed in and by the equipment in which a variable is controlled." For example, the steam-jacketed kettle, Fig. 1, is a piece of equipment for the process of heating water.

The automatic controller, often considered as only the instrument proper, actually is defined as "a mechanism which measures the value of a variable quantity or condition and operates to correct or limit deviation of this measured value from a selected reference." So defined, it includes physical parts outside the instrument case. All the controller component parts and their general function are illustrated in the example in Fig. 1 by a simple form of recording thermometer controller.

Water temperature is measured by a thermometer bulb which is called the *primary element*. Water is the *controlled medium*, while temperature of the water is the *controlled variable*. The thermometer bulb is part of the controller *measuring means*, which also includes (1) the capillary tubing connecting the liquid fill of the bulb system to (2) a spiral pressure element inside the instrument case for positioning (3) the recorder pen on a paper chart. Another type of temperature measuring means employs a thermocouple as a primary element to develop a minute voltage in accordance with the thermocouple temperature, from which a measurement is made by means of an electronic potentiometer that balances a calibrated voltage against the thermocouple voltage.

The controlling means includes (1) a *controlling mechanism* in the instrument (such as an electric contact actuated by the recorder pen) and (2) a power-operated *final control element*. The latter element in this case is a control valve on the steam line, wherein a plug is seated on or raised from a port in the valve body by means of a solenoid (termed in general a *power unit*). Operation of the solenoid, and through it, the control valve, is governed by the instrument contact action.

One air-operated control valve, known as a diaphragm motor valve, actually incorporates its power unit (diaphragm motor) and final control element (control valve) in one integral unit. Other examples of final control elements are butterfly valves, louvres or dampers, and contactors which directly control electric heating elements.

In the example of Fig. 1, the steam used to heat the water is called the *control agent*, which is always regulated by the final control element. In general, the control agent is the medium for effecting changes in the controlled variable and may be practically synonomous with the controlled medium in flow, pressure, and liquid level applications.

The fluid heat exchange equipment, Fig. 2, illustrates the terms defined above in a more general manner. The equipment and the automatic controller are always installed so that the initial action within the process (such as a temperature change) and the counter-action of the automatic controller form a closed circuit of action. Thus lags which slow response in this circuit can be found both in equipment

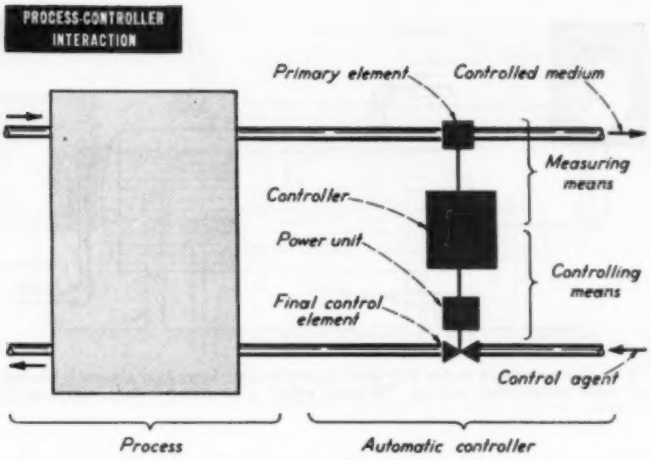



**Fig. 2—Fluid heat exchange equipment illustrates grouping of components named in Fig. 1 and defined in text. Process and controller make closed circuit of action**

and controller. In either place, they can affect the quality of automatic control, as discussed below.

### Basic Process Characteristics

Every process exhibits two familiar effects which are the prime factors influencing selection of automatic control equipment: (1) changes in the controlled variable due to altered conditions in the process, termed generally *load changes*, and (2) a delay in the time required for the process variable to reach a new value when load changes do occur, known loosely as the *process lag*. Actually the latter is caused by one or more of the more specific process characteristics termed *capacitance*, *resistance*, and *dead time*.

Following a brief consideration of the nature of load changes, each of these characteristics, which has a particular bearing upon the manner in which a process reacts, will be defined and its effects discussed.

### Process Loads

Process load is the total requirement by the process for the control agent at any one time. In a heat exchanger, for example, a fluid may be continuously passing through tubes in a chamber in which steam (the control agent) flows. A certain quantity of steam is required to hold temperature at a given value when fluid flows at a given rate. An increase in flow requires a greater quantity of steam and thus constitutes a change in process load.

Process load is seen to be directly related to position of the final control element, such as a valve, required to maintain the controlled variable at its *set point*. A load change causes deviation of the variable, requiring a new position of the final control element. Magnitude and rate of load change are later shown to be prime factors in the application of automatic controllers.

Load changes in a process are often not easily recognized. A change in any of the variables associated with energy or material balance in a process constitutes a load change. Among the many sources of such variations are:

(1) Variations in the demand for control agent by the controlled medium, such as changes in flow rate or temperature of the heated fluid in the example cited.

(2) Changes in quality of the control agent, in heating value of fuel gas, or pressure of steam.

(3) Uncontrolled variations in flow of control agent, such as caused by varying pressure in a fuel oil line.

(4) Changes in ambient conditions, such as varying radiation losses from a furnace with changes in ambient temperature (of particular significance in out-of-door installations).

(5) Variable quantity of heat generated or absorbed by a chemical reaction (exothermic and endothermic).

### Capacitance

A bar of metal can absorb and store heat energy supplied to it. Also a vessel can store up liquid in an amount dependent upon the size of the vessel. Such a characteristic in a process is commonly referred to as storage capacity, a measure of the maximum quantity of energy or material that can be stored.

A more useful term, however, is capacitance. It is the change in quantity of energy or material per unit change in some reference variable, usually the controlled variable. In a thermal process, for example, if 200 Btu are required to raise the temperature of the controlled medium 10 F, the capacitance would be 200/10 or 20 Btu per deg F.

The important distinction between capacity and capacitance is emphasized in Fig. 3 which shows two vessels of equal liquid volume capacity but widely differing in capacitance. Here the reference variable is vertical height in the vessel and would be the controlled variable in a liquid level control application. The shorter vessel has twice the capacitance of the taller and requires different controller responses.

### Capacitance Lag

In any equipment, operated as either a batch or continuous process, a capacitance which is large compared to flow of control agent is predominantly favorable to control. As a fly-wheel on a steam-driven electric generator stabilizes power output, so a relatively large process capacitance tends to keep the

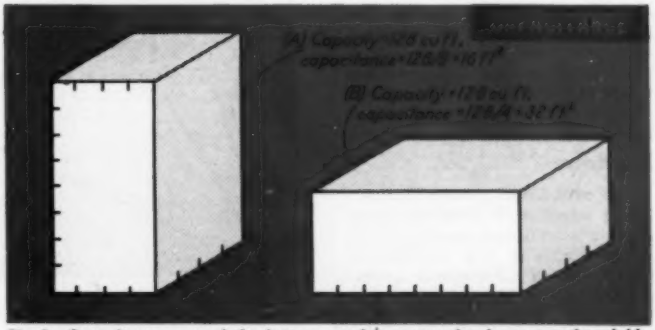


**Fig. 3—Capacitance, one of the factors causing process lag in measured variable, is change in quantity per unit change in variable. Capacity is the total volume**

controlled variable constant in the face of load changes in the system.

In Fig. 4, heat is applied to a vessel containing a considerable volume of the liquid in which a thermometer is immersed. Slight changes in the rate of flow, even firing of the vessel, minor variations in heat input, or sudden changes in ambient temperature will not seriously affect the controlled temperature. The mass of liquid exerts a stabilizing influence and tends to iron out changes which these variables might cause.

On the other hand, Fig. 5 illustrates a high velocity heat exchanger with a thermometer bulb located in the exit liquid line. Rate of fluid flow through the process is identical with that of the first process, but a comparatively small volume is in the tubes at any one time. Compared to the first process, there is no stabilizing mass influence. The total volume is small compared to rate of through-put, heat transfer and heat supply. Slight variations in rate of feed or rate of heat supply will be reflected almost immediately in the temperature measuring instrument, and, if the process were manually regulated, would require continuous vigilance to hold temperature constant.

Although over-all effect of capacitance is favorable, it does introduce a lag between the time a change is made in the control agent and the time the controlled variable reflects the change. In a boiler, for example, some time (dependent upon the capacitance of the water relative to the heat supply) is required for the water to reach a sensibly higher temperature when heat supply is increased. Fig. 6 shows graphically the various ways the temperature could approach its new value. Note that rate varies inversely with the capacitance and, that in each case, the change starts out at the maximum rate and gradually decreases. This is typical of equipment involving only one significant capacitance.

In automatic control, corrective action brought about by the controller to maintain balance in the process is dependent upon the relative rate at which the process reacts. The first step in analysis of a process should, therefore, include a consideration of its capacitance characteristic.

## Resistance

The second basic process characteristic is resistance. It is defined as opposition to the flow of energy or material. In electricity, it is expressed in Ohm's Law as the potential (volts) divided by the rate of current flow (amperes). Similarly, when heat is transferred by conduction through a solid, a temperature drop, dependent upon the composition of the material occurs. *Thermal resistance* is the change in temperature needed per unit rate of heat flow, the latter usually being expressed in Btu per sec.

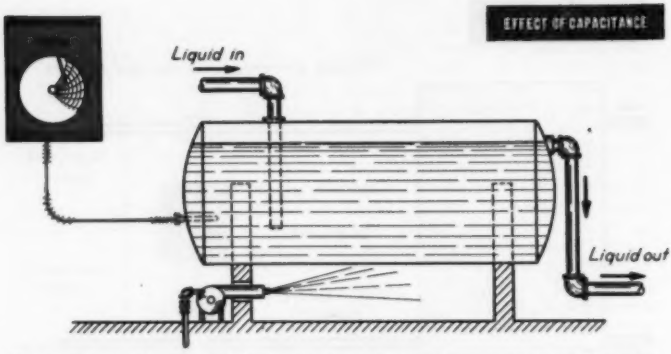



**Fig. 4—Volume of tank means high capacitance because large heat change is needed for small temperature change. "Flywheel effect" absorbs variations, aids control**

Resistance is the reciprocal of thermal conductance and can be calculated for many common materials from thermal conductivity constants listed in engineering handbooks. Designers of heat exchangers and boilers know that gas and liquid films on the tubes create a more serious resistance to heat flow than do the metal walls of the tubes themselves. These effects also can be calculated and cannot be neglected.

Units of resistance for other common process variables are similarly defined. With flow, a presure drop (psi) per unit of fluid flow (cfs) occurs. Likewise, for liquid level the head loss (ft) divided by the flow (cfs) to or from the vessel defines resistance. Usually, the characteristic is significant only in thermal process.

## Transfer Lag

Many processes, particularly those involving temperature control, have more than one significant capacitance. If a flow of heat or other energy passes from one section having capacitance through a resistance to another, a lag of a distinctive type, transfer lag, occurs. Its effect is illustrated in Fig. 7. Steam coils are imbedded in a high heat capacity jacket surrounding a kettle containing a well-stirred liquid which is to be maually controlled at a definite temperature. An indicating

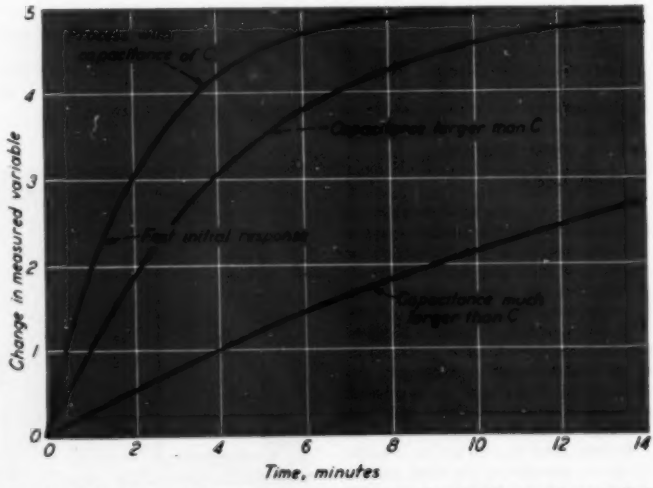



**Fig. 6—Although favorable, capacitance introduces lag in change of controlled variable. Curves are typical where only one significant capacitance is involved**

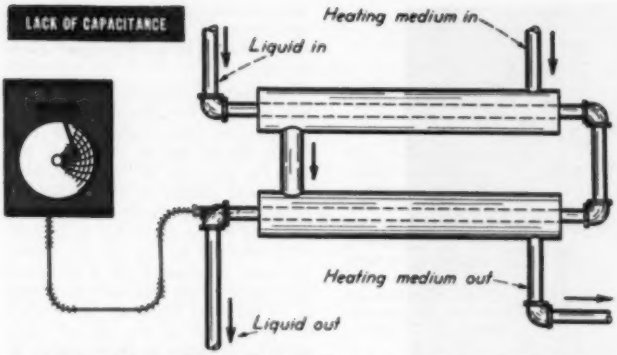



**Fig. 5—Heat exchanger has same liquid flow as Fig. 4, but low volume means low capacitance. Variations affect thermometer immediately, make control difficult**

thermometer with its bulb in the liquid is the basis for control of the hand valve regulating steam flow.

So long as conditions in the system are constant, steam flow is sufficient to maintain a temperature somewhat greater than the liquid temperature, as required by the temperature drop through the jacket resistance. If an increase in liquid flow into the kettle occurs, a drop in temperature is immediately reflected in thermometer indication and the steam valve would be opened to provide a greater heat transfer rate — that is, a higher jacket temperature. Thermal capacitance of the jacket, however, retards building up the higher temperature on the supply side.

Temperature rise of the liquid would thus follow one of the curves shown in Fig. 8, depending upon the relative values of the capacitance and resistance in the process. The notable difference bewteen these transfer lag curves and the capacitance lag curves of Fig. 6 is that the temperature does not respond instantly at maximum rate. Thus, transfer lag retards initial reaction.

Transfer lag in temperature control is always unfavorable because it limits the rate at which heat input can be made to affect the controlled temperature. It tends to cause overshooting of the set point. From the above example, a larger resistance increases the thermal head necessary for heat transfer. Furthermore, when load changes occur, a larger supply capacitance lengthens the time required to change the temperature head to a new value.

In heat exchangers or boilers, surfaces fouled by sludge or corrosion and poor film coefficients from insufficient fluid velocities result in high resistances and consequently large transfer lag. The resultant higher thermal heads can produce large overswings in the controlled temperature.

## Dead Time

In certain processes, particularly continuous ones, where it is necessary to transfer heat or other energy by means of a fluid flowing through a distance at a given velocity, a third type of lag termed dead time often occurs. For example, in a furnace type commonly used in the petroleum refining industry, oil is pumped at a constant rate of flow through hundreds of feet of tubing which line the walls of the heater. Appreciable time is therefore required for a given portion of the oil to pass through the heater.

If ideal conditions exist in which every variable, except the inlet oil temperature is constant, it is evident that there still would be considerable lag in the recording of an inlet temperature change if the primary element were located in the outlet line.

If further, the outlet temperature were to be regulated, control action and therefore heat input, would be delayed that length of time.

Dead time is often created by installation of the control valve or measuring element at a distance from the process. For example, if a heated fluid flows from a heat exchanger at the rate of 200 fpm and a thermometer bulb is located 50 ft from the outlet, then a delay or dead time of 0.25 min will be introduced before any change in the process is detected by a temperature measurement.

If a chemical reaction in the process takes place slowly upon addition of a control agent, this also would be dead time. It is sometimes necessary to locate the primary element at a point where completion of the reaction is assured. The control of pH often involves such a factor. Higher reaction temperatures tend to reduce dead time from this cause because chemical activity, or reaction velocity, is increased.

In general, dead time introduces more difficulty in automatic control than any other lag in the controlled system. The effect of dead time, shown graphically in Fig. 9, is to cause no change in the process reaction characteristic but rather delays it. During the delay, the controller is helpless since it cannot initiate a corrective action until a deviation occurs.

## Modes of Automatic Control

Mode of control is the manner in which the controlling means responds to a change in the measured variable caused by the various load changes previously discussed. Common modes are: (1) two-position, (2) proportional, (3) proportional-reset, and (4) proportional or proportional-reset plus rate action. Controllers employing the first three find the widest usage and are available in both electric- and pneumatic-operated types.

Definitions and general application of the various modes are covered in this section. In general, the more complex and unfavorable the process characteristics, the more sophisticated the controlling means must be. Proper application of an automatic controller, however, should be judged by the simplest system possible to do the job, with the attendant advantage of lower first cost of regulating equipment.

## Two-Position Control

In this mode, as the name implies, the final control element, such as a valve, is quickly moved to one of two positions when the controlled variable departs a predetermined amount from the set point of the controller. The

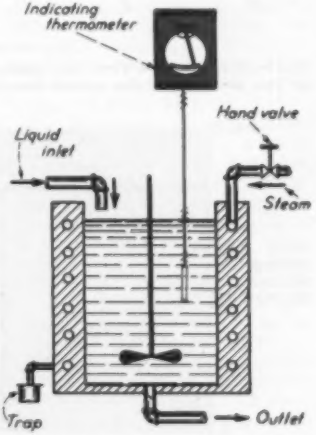



**Fig. 7—Illustrating transfer lag, capacitance of the jacket, resistance of jacket and capacitance of the liquid slow heat transfer from steam coils**

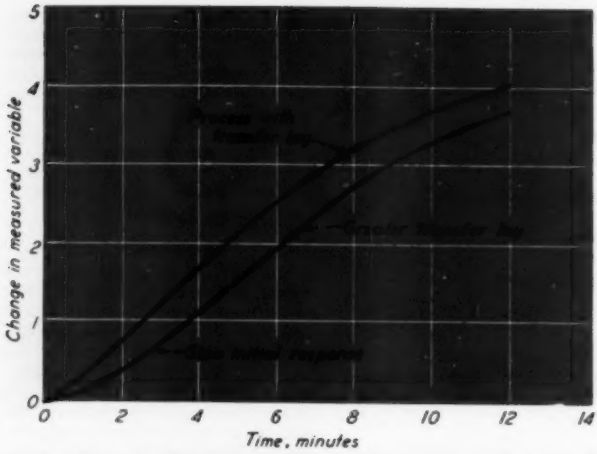



**Fig. 8—Transfer lag effect, caused by energy flow from one capacitance through resistance to another, is slower initial response compared to curves in Fig. 6**

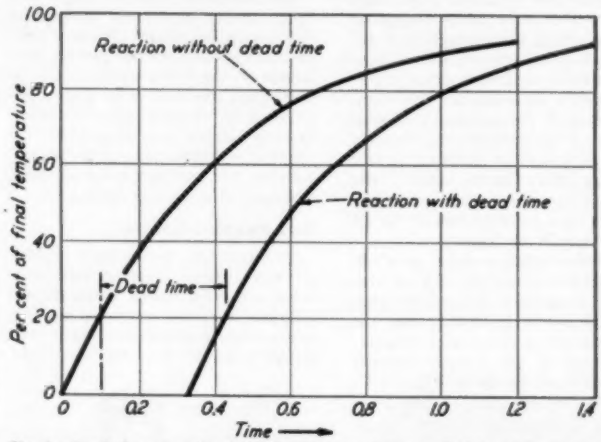



**Fig. 9—Dead time, as when inlet temperature is controlled by thermometer in outlet line, means controller cannot function until inlet change reaches thermometer**

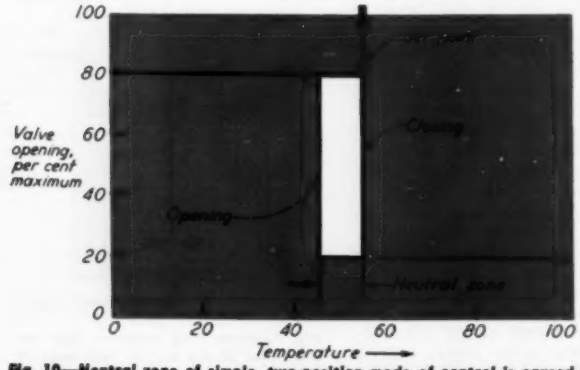



**Fig. 10—Neutral zone of simple, two-position mode of control is caused by differential between opening and closing points. Helps reduce cycling, may be small**

two positions need not be fully open or fully closed, in which case it is sometimes referred to as "high-low" mode of control.

Amount of instrument pen departure necessary for control action in the two-position mode varies with controller design, but in general is less than two per cent of the instrument range and usually is not readily adjustable. This characteristic, the *neutral zone* of the controller, is illustrated graphically in Fig. 10. As shown, the valve is adjusted for a minimum opening of 20 per cent and a maximum of 80 per cent. When the pen reaches the upper end of the neutral zone, the valve is caused to move quickly in the closing direction to its minimum position. It remains in this position until the pen moves downscale again to the lower end of the zone where the valve is actuated to open again.

As in the case of thermostat controllers, the overlapping control action is usually desirable so as to avoid continuous cyclic operation of the final control element. Since the two valve positions must necessarily supply either too much or too little of the control agent, the controlled variable is inherently caused to cycle, or change periodically between high and low. Under almost ideal conditions, the magnitude of its variation may be made extremely small.

## Two-Position Applications

Because of its simplicity, two-position control is very popular, and it is often adequate. In general, it functions satisfactorily between the desired control limits if the process has the favorable characteristics of large capacitance and minimum transfer lag or dead time, and the valve travel (or other final control action) is adjusted to permit an input just slightly above and slightly below requirements for normal operation.

With changes in load, action of two-position control is such that the controlled variable will deviate markedly from the average cycling (or high and low periods) in an amount dependent upon the magnitude of the load change. Furthermore, cycling at the new load will be lower or higher in accordance with the direction of the load change.

Although the two-position mode will accommodate load changes to a degree, such changes must not be rapid. It is ideally suited, for example, to control temperature in a kettle where the only load is that of maintaining a heat balance against radiation losses. Also, in such a case, the capacitance is relatively large and valve adjustments are easy to make.

## Proportional Control

In proportional mode controller action, a continuous linear relation exists between the deviation of controlled variable and position of the final control element. Thus the change of the controlled variable is simply repeated and amplified, say in the valve action. For purposes of flexibility in application, a calibrated adjustment for the *proportional band* (throttling range) is usually provided in the controller.

The proportional band is defined as the range of values of the controlled variable which corresponds to the full operating range of the final control element. It is usually expressed as a percentage of the full scale range of the controller and the adjusting dial is so calibrated. For example, if a temperature controller has a range of 0 to 1000 F and functions to move a control valve through its full operating range as the recording pen moves from 500 to 700 F, the proportional band adjustment would be 200/1000 or 20 per cent.

The set point of the controller is at some intermediate value of the controlled variable within the proportional band, usually at or near the middle. With the controlled variable at the set point, however, it is generally necessary to change the amount of valve opening in order to provide the proper normal rate of control agent flow. This is accomplished by a second adjustment in the controller termed *manual reset*.

The effects of proportional band and manual reset adjustments are illustrated graphically in Fig. 11. Curve *A* shows a 40 per cent band setting (40 to 80 per cent on the scale) with the set point at the middle of the band, in which case the control valve is half open. If a lower flow of the control agent—such as a 25 per cent valve opening—will suffice to maintain the controlled variable at the set point, manual reset can shift the proportional band upscale as shown by curve *B*. Likewise, if a larger valve opening of, say 75 per cent is required, manual reset can shift the band downscale, as shown by curve *C*.

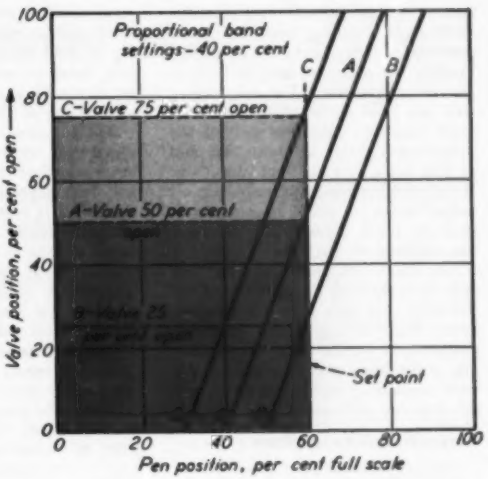



**Fig. 11—In proportional mode, control element opening will vary with the deviation of controlled variable from set point. Manual reset changes the control element opening at the instrument set point**

## Proportional Control Uses

By permitting intermediate positioning of the control valve, proportional control can more nearly regulate agent flow to meet process demand. In contrast to two-position control, it initiates a corrective action almost immediately, at a rate and of a magnitude directly proportional to the controlled variable deviation. Since there is a fixed relationship between the control variable and the valve opening, however, proportional control cannot automatically accommodate load changes and still maintain the controlled variable at the set point.

For example, with reference again to the graph, assume that the proportional band and manual reset are adjusted as for curve *A*, which provides a 50 per cent valve opening when the pen is at the set point of 60 per cent. Now suppose that there is a change in load in the process such that a 75 per cent valve opening is required to maintain the desired value of the controlled variable.

The only possible way the controller can automatically provide this valve opening—that is, without manual reset being used—is for the pen to be at 70 per cent of scale, or 10 per cent above the set point. This deviation is known as *offset*. Actually, where process load changes are small or infrequent and some offset, or a temporary larger offset is permissible, proportional control is quite adequate to regulate the variables.

The general effect of larger process capacitance is to permit narrower proportional band settings. Smaller bands result in faster corrective action and closer limits of control; hence larger process capacity is advantageous with proportional control. Greater transfer lag or dead time requires a wider proportional band and is, therefore, considered a limitation.

Another consideration is existence of load changes in the presence of unfavorable process characteristics which require wider proportional bands. In such cases, the amount of offset occurring with load changes varies directly with the band setting and may become excessive with the wider band.

## Proportional-Reset Control

With proportional control, manual reset is necessary in order to provide for different valve openings when the variable is at the set point and thereby compensate for load changes. This action can be automatic.

The effect of automatic reset is illustrated graphically in Fig. 12. The controller has a 30 per cent proportional band and, at zero time with the temperature at the set point, provides a 50 per cent valve opening. At a time of four minutes, the temperature begins a rise slightly above the set point, due to decrease in load, and reset action immediately starts to shift the band in the opposite direction so as to decrease the valve opening. The amount of valve opening is shown by the position of the temperature in the proportional band and after several minutes the valve approaches a closed position. This action thus forces the variable toward the set point.

The proportional action functions simultaneously with the reset action in producing a valve motion. For example, if the controlled variable suddenly deviates 10 per cent from the set point, proportional action immediately causes the corresponding corrective movement of the control valve. Reset action then functions to return the variable to the set point, even though the new valve opening continues to be required for a load change.

The proportional-reset controller has two adjustments: a proportional band adjustment, as described previously, and a reset rate adjustment. The latter, in combination with the band setting, determines the rate at which the proportional band is shifted when a deviation occurs and is set in accord-

ance with the control requirements. With a given setting, reset rate is proportional to deviation of the controlled variable but continues only so long as any deviation exists. For example, a four per cent deviation from the set point causes a continuous shift of the proportional band at twice the rate of that for a two per cent deviation. When the controlled variable is returned to the set point, reset ceases to shift the band, leaving it in the position attained at that time.

The reset response depends not only upon the reset adjustment and the deviation, but also upon the proportional band setting, being inversely proportional to the latter. For example, if the band setting is halved, the reset response is doubled, even though the reset rate adjustment is unchanged.

### Proportional-Reset Uses

The proportional-reset mode is the most generally useful and is particularly important in the automatic control of continuous operations. With the exception of a few special cases considered under "Rate Action," it can handle almost all combinations of control problems, even when unfavorable.

A few general observations can be made concerning the application of proportional-reset control. Primary advantage of this mode, of course, is its elimination of offset due to load changes so that the controlled variable is maintained within close limits of the set point at all times. Smaller process capacitance permits a higher reset rate when there is little transfer lag or dead time, enabling the controller to counteract offset more quickly. Transfer lag or dead time in the controlled system, however, requires that reset rate be decreased in order to avoid excessive cycling of the controlled variable.

The limitation of applying proportional-reset control lies only in the large period of cycling and the attendant slow response when appreciable dead time is present in the controlled system. Transfer lag is not a limiting factor so long as the measuring means is sensitive. If the latter is sluggish, transfer lag is converted to a dead time, so that the proportional band must be wider and the reset rate slower.

Processes having large dead time (2 min or more) or large transfer lag occasionally prove difficult to control even with the proportional-reset mode. With the latter, the proportional band must be exceptionally wide and the reset rate unusually slow in order to avoid excessive cycling. Thus, when load changes occur, a rather wide deviation is obtained and a longer time is required for the controlled variable to return to the set point. In such an application, which is most often found in temperature control, the addition of rate action to the proportional or proportional-reset mode usually solves the control problems.

### Rate Action

Basically, rate action provides an initially large corrective action so that the final control element is at first moved further than would normally occur with proportional or proportional-reset action. Then the controller functions to remove this effect, leaving only the normal corrective action to determine the position of the final control element. The result is an early, extra change in the control agent supply which tends to counteract the unfavorable effect of the process lag in the regulating action.

Rate action is defined as that in which there is a continuous relation between rate of change of the controlled variable and rate of positioning of the final control element. Thus, proportional-reset plus rate action produces responses in proportion to (1) the deviation of the controlled variable (proportional action), (2) the amount and duration of the deviation (reset action), and (3) rate of change of controlled variable (rate action).

### Graphic Summary

The individual control responses and combined response of this mode are illustrated graphically, Fig. 13. Rate action occurs only when the controlled variable is changing and is dependent upon the proportional or proportional-reset response of the controller for its functioning.

The most notable advantage of using rate action for counteracting the effect of dead time is the reduction in the period of cycling. Thus the controlled variable is stabilized at the set point more quickly when load changes occur. An adjustment is provided in controllers employing it so that the response can be adjusted in accordance with the amount of process lag.

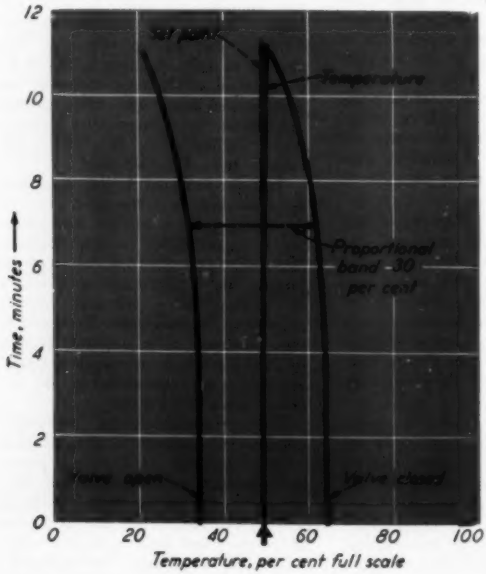



Fig. 12 (left)—Automatic reset shifts Curve A, Fig. 11 towards B or C to meet new load needs. Reset starts when controller functions and varies with time as shown in this graph

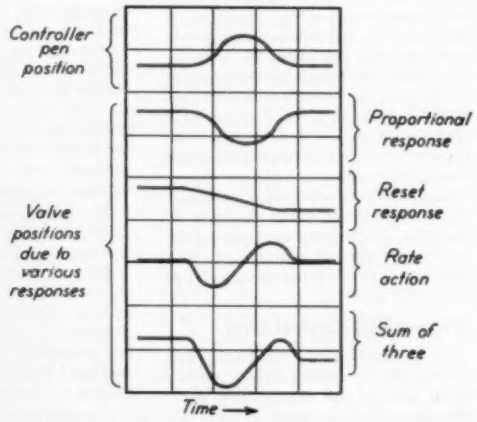
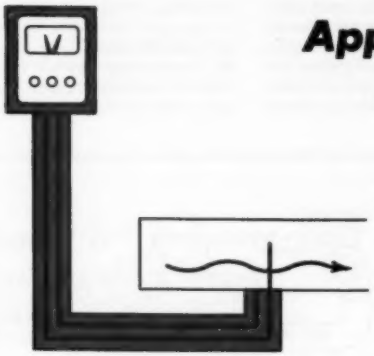



Fig. 13 (above)—Response of control element to change in load demand for the various modes of control. Rate action provides large initial response, helps avoid dead time



# Application of Automatic Control to measuring and controlling airflow in boilers

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IN SELECTING MEANS of measuring the flow of air for combustion in a boiler furnace, consideration should be given engineering principles of flow metering as they might apply to the problem.

Some factors which affect accuracy of measurement of the flow of air for combustion are: (1) variations in size and shape of the orifice used, (2) variations in temperature of the measured air (or the combustion gases), (3) change in quantity of dirt that accumulates in the "orifices" and (4) change of pressure of the measured air or combustion gases.

In addition to these considerations, the conditions under which the boiler is to operate under automatic control must be studied to assure automatic operation over as wide a range and under as varied conditions as possible. Satisfactory results may be measured by $CO_2$ or oxygen content of the flue gases, or the relationship of airflow to steam flow.

Fans, stack, economizer, preheater and forced draft duct work must be analyzed as to their capacities and draft or pressure losses or differentials. This will permit the best selection of location and method of measurement.

Whenever a boiler efficiency meter, which measures the relationship of airflow to steam flow is used as a guide to efficient combustion, selection is already made as to means of measuring airflow. The airflow record of the boiler efficiency meter should be taken from the same connections as are used by the air flow controller for air measurement so that both receive the same measuring impulses.

In selecting the best location of an orifice or method of measuring airflow for any particular boiler on which an airflow controller is to be used, the following methods are considered.

## Method "A" Draft Loss Across Boiler Passes

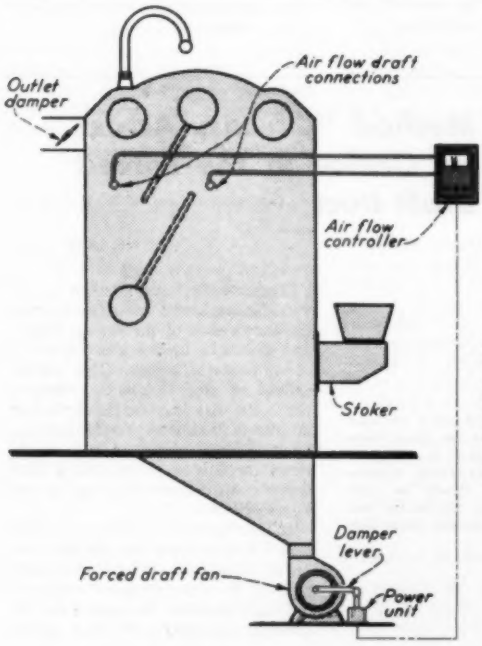



**Fig. 1—Measurement of draft loss across boiler passes is the most common method of measuring the air flow. In some cases, loss is too low for accurate control use**

By far the most frequently used method of measuring airflow is that of measuring the draft loss across boiler passes, as shown in Fig. 1. Most boilers should have sufficient draft loss and the taps may be installed in the proper location in almost every design of boiler. This method measures the total volume of combustion gases, including air that has leaked into the furnace.

The boiler passes themselves remain fairly clean in most cases due to the efficiency of soot blowers and, when taps are located so as not to include the first pass or slag screen at the boiler, the differential remains fairly uniform. Temperature error due to varying temperatures at different locations in the boiler passes can be reduced to a minimum by compensation for the temperature effect (stack

action) with proper vertical location of draft taps (except on horizontally baffled boilers).

In some boilers, however, draft loss is insufficient to permit a controller to regulate the airflow closely. Although this method is the most common, in some cases it may not give the best measurement because of variables such as cleanliness of the passes and temperature of the gases. Also, this method measures air which has leaked in through the boiler setting or where it does not enter into combustion. It is therefore desirable to use a method of measurement which will be free from these variables, and consequently give more satisfactory results.

## Method "B" Pressure Loss Across Airside on Air Preheater

When the boiler is equipped with an air preheater, it may prove to be an excellent means of measuring the flow of air for combustion.

In practically all air preheaters draft loss on both air and gas sides is sufficient to operate the airflow controller. However, the gas carries dirt which tends to lodge in the tubes and change the size of the "orifice," while the air side remains clean since it carries fresh air. It is usually better to use the pressure loss across the air side of the heater as a measurement of flow.

Temperature variations in the air preheater are at a minimum since it delivers an almost constant temperature air for all loads. The "stack" effect in a vertical air preheater is compensated for either by making the connections to it or in the controller, so that it is of little importance.

In practically all cases, the preheater carries the total air including primary, overfire and secondary air. Sometimes tempering air is also taken in but in most cases this is negligible and, since it is generally proportional to the primary air, not important. In some cases, it may be desirable not to measure the over-fire air. For example, when it is used for smoke elimination, it is "extra" air to burn the volatiles and reduce the smoking conditions.

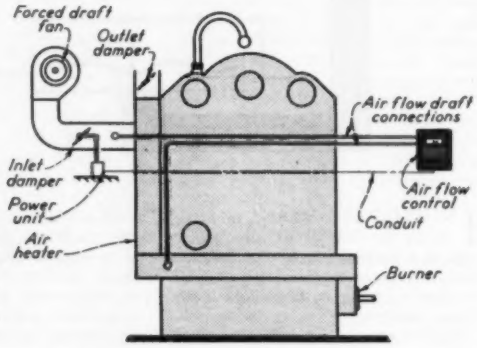



**Fig. 2—Loss across air side of an air preheater is usually adequate and the openings remain clean enough to operate a controller. No load is added to blowers**

Using the air preheater as an orifice places no additional load on any fan since the pressure loss that normally exists is simply measured. The air side of the preheater, therefore, is an almost ideal orifice and is recommended wherever possible for air flow measuring purposes. It is essential, however, that all air used for combustion pass through the air heater so that it will be measured.

## Method "C" Loss Across an Orifice in the Forced Draft Duct

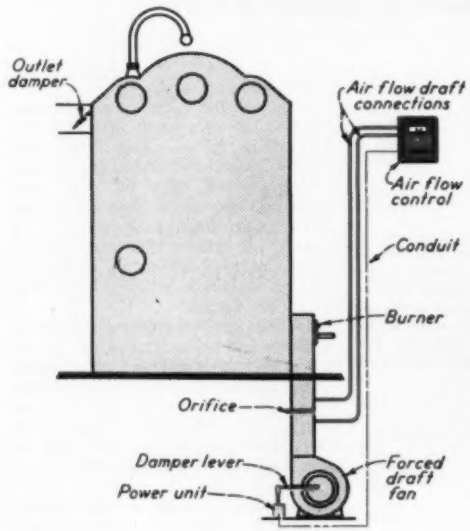



**Fig. 3—An orifice gives the best theoretical method of measuring airflow and should be used when the boiler has insufficient draft loss**

Theoretically, measurement of the pressure loss across an orifice provides the best means of measuring airflow, and should be used wherever practical conditions will permit. This method should be used if possible whenever the boiler has insufficient draft loss. At least 0.50 in. water draft loss should be available at maximum load. Sometimes there is an extra forced draft damper in the duct which can be used as an orifice.

In many cases, layout of the air ducts makes a satisfactory installation of an orifice impractical. In addition, a small part of the static pressure output of the fan is absorbed in creating the differential pressure across the orifice,

and slightly increases power consumed by the fan.

In general, an orifice in the breeching, economizers, the gas side of air heaters and similar points are not considered very good means of measuring airflow because of the variations in cleanliness and temperatures. In addition, available draft is generally not sufficient to permit use of any additional restrictions to flow of combustion gases as would be created by the use of an orifice. However, they may be used when no better means is available. Their use, however, may make more frequent checking and adjusting of the airflow controller necessary to compensate for the variables.

## Method "D" Pressure Loss Across Burners Used as an Orifice

The use of burners as an orifice, by measuring the loss in air pressure between the burner wind box and the draft in the furnace, is a very good means of measuring airflow. It may be used in preference to Method "C" and is recommended with the wide range return line type of oil burners.

Where the installation consists of several burners, pressure loss remains the same regardless of the number of burners in operation. This is due to the fact that when a burner is in service the air louvers are always left wide open and therefore constitute a fixed orifice. When the burner is out of service the louvers are closed. The air that passes through each set of louvers is that required for use with the oil consumed by that particular burner. The pressure drop across one or several burners in operation therefore remains the same. Changes in tangential dampers for directing the flame have less effect than is generally presumed and such changes can be rectified at the controller and with less disturbance to the controller than if methods measuring total airflow were used.

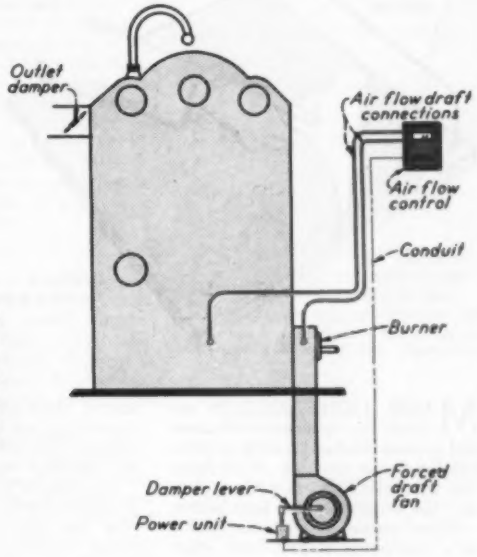



**Fig. 4—The pressure drop across burners should be used with wide range oil burners to keep air-fuel ratio constant when number of operating burners is variable**

Temperature variations and errors due to variable cleanliness conditions are negligible with this method of airflow measurement. It must be used with wide range oil burners to keep the air-fuel ratio constant with a variable number of burners in operation. This method cannot be used with more than one steam or mechanical atomizing burner per boiler. When two or more such burners are used, one of the other methods of airflow measurement must be employed.

### Control of Airflow

Little need be said as to the means of controlling the rate of airflow for combustion. Positioning of dampers (single or multiple leaf, or vortex types) may be used and controlled with equally satisfactory results. The dampers may be either at the inlet or outlet of the forced draft fan.

Speed of the forced draft fan can be used as a means of controlling the airflow. Control of fan speed may be by a valve in the steam line to a turbine drive, or by actuating a lever controlled governor at the turbine. It may also be regulated through an hydraulic coupling of either the scoop type or the reversing pump type. Fan speed may also be controlled through the operation of an electric type coupling.

When extremely wide range of control is required or other conditions would dictate its use, a system of cascading the operation of damper and fan speed may be used. With such an arrangement, the control of airflow would be by regulating fan speed from maximum load conditions down to the lowest satisfactory speed; then control is automatically transferred to the operation of the damper which is positioned to regulate airflow for the lower load conditions. The control is automatically transferred back to fan speed variation with an increased load.

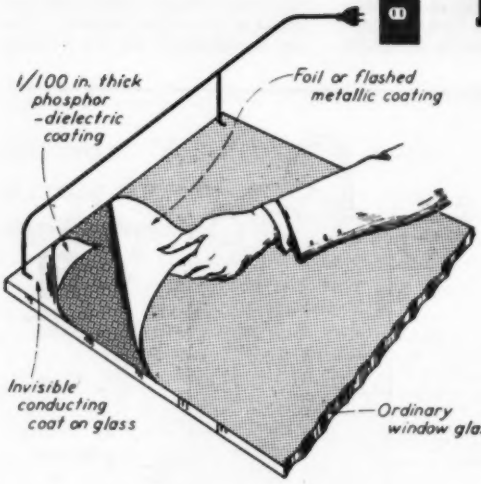
### Control of Forced Draft

Because air for combustion comes from the forced draft fan, it is generally most desirable to control the amount of forced draft for air volume and maintain the furnace draft constant by controlling the induced draft.

### Conclusion

Several more common methods of measuring and controlling flow of air for combustion have been outlined. There are other methods which may be more desirable for the individual application than those described. The importance of providing for a satisfactory means of measuring and regulating flow of air cannot be over-emphasized and should be given careful consideration when the boiler installation is being designed. The care taken at that time may determine, to a large extent, the successful operation of automatic combustion control.

# ENGINEERS' PREVIEW OF


1/100 in. thick phosphor -dielectric coating
Foil or flashed metallic coating
Invisible conducting coat on glass
Ordinary window glass

**Here are the electrical traits of a promising new area light source that may be used for:**

- **Luminous panels for normal seeing purposes**
- **Dials for instruments, meters and clocks**
- **Indicating devices, switch plates, rails**
- **Viewing-plates for films or inspection**
- **Decorative panels, shelves and table tops**

***Fig. 1—Electro-luminescence occurs when a suitable phosphor is dispersed in a dielectric between two conducting layers and subjected to a changing electrostatic field. The result is a large area, low brightness light source***

MAJOR LIGHT SOURCES include the incandescent filament and gaseous discharges, with or without fluorescent coatings. With these, the "condenser light" may take a place as a low brightness, area light source.

When certain materials are placed in a fluctuating electric field under proper conditions they are excited to luminescence. This constitutes the phenomenon of electro-luminescence (not to be confused with cathodo-luminescence). No intermediate phenomenon such as a glow or arc discharge appears to be involved. The materials luminesce directly under the influence of the electric field which must, however, be in the process of changing in intensity, and apparently is a direct transformation of electrical energy into light.

Electro-luminescence may be produced with a film of phosphor dispersed in a dielectric and placed between two conducting plates. At least one of these plates should be light transmitting for the generated light to emerge. The device may be regarded as a luminous capacitor.

A coating of phosphor suspended in a solid dielectric is spread uniformly over the conducting surface of so-called "conducting glass", Fig. 1. The phosphor-dielectric film is then coated with a metallic conductor, except for a narrow strip around the edge. One effective method uses vaporized aluminum. Connections are made to a contact strip along one edge of the conducting glass and to any convenient spot on the metallic backing layer.

A number of substances can be excited in this device. Some are also fluorescent under ultra-violet or cathode ray excitation, some are phosphorescent, and some are neither. No direct correlation has been observed.

Emission of light is contingent upon fluctuating field intensity. A brief flash of light may be observed when a d-c potential is applied to the plaque and another when the charge is permitted to leak off, but no light at all is emitted if the d-c potential is constant in value.

For Fig. 2, the output of a square wave generator was applied to the plaque terminals. Simultaneous cathode ray tube graphs were taken of the applied voltage and of the light emitted. Luminescence occurs when the potential is changing and short bursts of light are emitted which are practically in phase with the voltage changes at the end of each half cycle.

**TABLE 1—APPROXIMATE VARIATION OF BRIGHTNESS WITH VOLTAGE**

| Line voltage, per unit | Brightness, 120 v unit | Brightness, 500 v unit |
|---|---|---|
| 85 | 48 | 65 |
| 90 | 63 | 75 |
| 95 | 80 | 83 |
| 100 | 100 | 100 |
| 105 | 122 | 115 |
| 110 | 142 | 130 |
| 115 | 168 | 146 |

**TABLE 2—APPROXIMATE VARIATION OF BRIGHTNESS WITH TEMPERATURE**

| Temperature, degrees F | Relative brightness per cent |
|---|---|
| 0 | 70 |
| 40 | 79 |
| 70 | 88 |
| 80 | 100 |
| 90 | 109 |
| 120 | 141 |
| 160 | 212 |

### Phase Relations

With a 60 sine wave source of supply, Fig. 3, the phase relationships between voltage, current, and luminescence may be obtained. Light emitted is in phase with the power absorbed by the dielectric. Current leads the voltage by nearly 90 deg. Most luminescence occurs when both voltage and current are in the same direction although in different quadrants. This of course is the period when the capacitor is absorbing energy.

Several factors affect intensity of light emitted. Thickness, resistivity and dielectric constant of the phosphor layer are all important, as are the voltage and frequency at which the device is operated.

Fig. 4 illustrates the relation between light output and voltage for a typical luminous capacitor operated at 60 c. Threshold of visibility is at a potential of about 25 v. Brightness increases rapidly with voltage over a

# CAPACITOR LIGHT SOURCE CHARACTERISTICS

considerable range until a limiting voltage, at which breakdown of dielectric occurs, is reached.

For greater brightness a small inexpensive transformer is introduced in the circuit to bring the voltage up to 400-500 v. This transformer would be no larger than a cigarette package for a panel a foot or two square, but multiplies the light output by twenty. This is ample for low level illumination of restaurants, elevators, theatre aisles, and many other decorative and architectural applications.

At a given voltage, light output increases with frequency as shown in Fig. 5, curve A. A variable frequency at a constant voltage of 100 v was applied. Except for some discrepancy in the neighborhood of 50 c, possibly due to resonance effect in the generating equipment, light output increases with frequency.

Curve B in Fig. 5 shows the relation between light output and power consumption at different frequencies. The linearity of this relation suggests that light is emitted each time the capacitor lamp is charged. The more times per second this is accomplished, the more light will be emitted.

It is interesting to note that no perceptible color change takes place on dimming but that a very definite color change has been observed with variable frequency operation. For example, a luminescent (condenser) lamp which luminesced in the yellow green at 60 c had a pale blue-green color at 3000 c. No explanation for this behavior is advanced although it may well be due to different decay rates of the phosphor components.

Spectral energy curves for blue and yellow lamps are shown in Fig. 6. By combining in proper proportions, white lamps may be made which have spectral energy curves like that shown by the dotted line. Color emitted depends on the particular phosphor used. In general, they are of the zinc sulphide type but require special formulation and processing to make them respond satisfactorily.

### Brightness Values

Green lamps have a brightness of about 0.1 ft-L at 120 v, 60 c and from 3 to 5 ft-L at 600 v. At 400 c brightness levels several times as high may be obtained. At present, efficiency is a few lumens per watt. A large part of the energy is consumed by dielectric losses.

Since there are no filaments, life of these lamps should be indefinite. Practical end of life will undoubtedly come when brightness has decreased to a level which is inadequate rather than at the usual abrupt filament or cathode failure. Sufficient test data is not yet available to permit accurate estimates, but indications are that useful life should be a matter of 2 or 3 yr.

In this brief report an attempt has been made to present, in preliminary fashion at least, the more important characteristics of the phenomenon of electro-luminescence as they are known at the present time. The report is from technical papers supplied by Sylvania Electric Products, Inc.

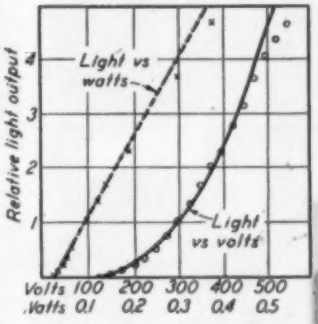



**Fig. 4—Output rises rapidly with voltage, needs transformer for brightness in panels designed for illumination**

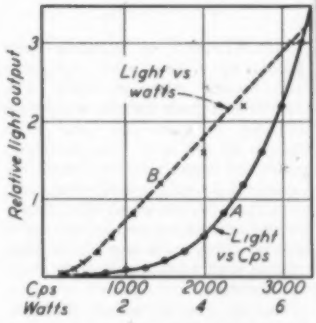



**Fig. 5—High frequencies mean more light, may bring new power sources to the lighting systems of the future**

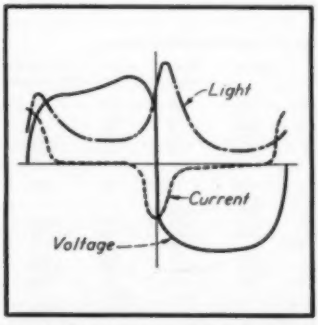



**Fig. 2—Square wave voltage shows output depends on rate of voltage change applied to the plates of the capacitor**

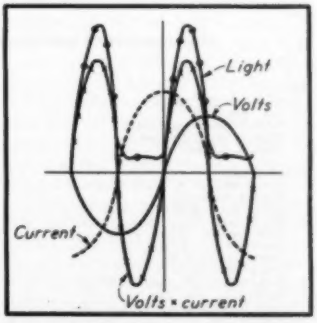



**Fig. 3—Light output is greatest when voltage and current are same polarity when capacitor is also absorbing energy**

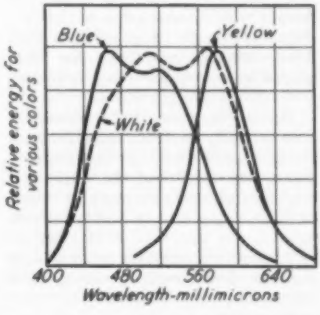



**Fig. 6—Color of light depends on the kinds and combination of phosphors dispersed in the capacitor dielectric**

# FIRING LOW-GRADE FUELS ON CHAIN GRATE STOKERS

**Here are factors to be considered when burning fuels with ash and moisture content exceeding 25 per cent and with heating values less than 11,000 Btu per lb. They include fine slacks, slurry from coal washing systems, filter cake and coke breeze, as well as a combination of these fuels and graded coals. Modification of steam generating equipment firing graded coal is required to maintain combustion efficiency**

**CHARLES H. MARKS, *Republic Coal and Coke Company***

IMPORTANCE of low-grade fuels looms up in times when high-grade fuels become scarce or costly. The price of low-grade fuels is usually not subjected to quite the same price changes as the more popular higher grades and it may often be found that the use of lower grades becomes economical. In periods of scarcity, considerations of economy are shelved and it becomes a question of keeping the plant running with whatever grades of fuels are procurable.

This situation of scarcity has predominated in Britain since the war. A great deal of work and investigation have been made on the combustion of low-grade coals. It may generally be said that the lowest grades are burned near their source and that quality increases with distance, due to the incidence of freight rates on heat cost. Most valuable experience has been gained in mining areas and near coke oven plants and gas works.

For the purpose of this discussion it is necessary to define what is meant by "low-grade fuel." In this article it means any solid fuel the total inert content (ash and moisture) of which exceeds 25 per cent or whose calorific value is less than 11,000 Btu per lb. In practice this definition refers to such fuels as fines, washery slurry, coke breeze, and unwashed smalls from low-grade seams.

The use of low-grade fuels requires either a plant specially designed for them or else modification of existing plant if the changeover is to be made successfully without interference with steam output.

## Performance Data

The accompanying table summarizes data obtained from several different power plants burning low-grade fuels, such as fine slacks, slurry, filter cake, coke breeze, and a combination of coke breeze and graded coal.

*Fine Slack* — The fine slack is seen to consist of 66.5 per cent fines passing a ⅛ in. screen and contain 23.5 per cent inerts. The moisture content was 14 per cent and this fuel was fed mechanically to the grate. The burning rate was 24.3 lb per sq ft per hr giving a heat release of 350,000 Btu per sq ft per hr. This was the optimum value and the grate area had to be designed accordingly.

If the fines could have been reduced by half, the combustion rate could have been increased by more than 50 per cent allowing in turn a smaller stoker. Generally speaking, dry fines can be burned on a chain grate without great difficulty, provided allowance is made for the limited rate of combustion set by the grit carry over.

*Slurry* — Slurry consists of finely divided coal, shale and clay particles

**PERFORMANCES OF LOW-GRADE FUELS ON CHAIN GRATE STOKERS**

| | Fine slacks | Slurry | Filter cakes | Coke breeze | Coal and coke breeze |
|---|---|---|---|---|---|
| **Fuel:** | | | | | |
| Moisture, per cent | 14.0 | 25.3 | 25.0 | 18.4 | ... |
| Ash, per cent | 9.5 | 13.9 | 12.0 | 12.1 | ... |
| Volatile matter, per cent | 29.9 | 22.0 | 19.5 | 3.1 | ... |
| Heating value, Btu per lb | 10,164 | 7,970 | 9,750 | 10,000 | 11,750 |
| Through screen, in. | 1/8 | 1/8 | 1/8 | 3/8 | ... |
| **Performance:** | | | | | |
| Firing method * | M | H | H | M | M-S |
| Firebed thickness, in. | 3.50 | 4.75 | ... | ... | ... |
| Under fire pressure, in. water | 0.75 | 0.90 | 0.45 | ... | ... |
| Firing rate, lb/sq ft/hr | 34.30 | 35.30 | 23.00 | 27.60 | 30.66 |
| Heat release, Btu/sq ft/hr | 350,000 | 280,000 | 224,000 | 276,000 | 340,000 |
| Steam pressure, psig | ... | 260 | 260 | 300 | 178 |
| Steam temperature, F | ... | 690 | 680 | 650 | 486 |
| Evaporation, lb/hr | ... | 43,000 | 40,000 | 30,000 | 10,500 |
| Evaporation, per cent of normal | ... | 86 | 133 | 100 | 100 |
| Stack $CO_2$, per cent | ... | ... | 12/13 | 10/11 | ... |
| Boiler efficiency, per cent | 89.7 | ... | ... | 69.4 | 79.96 |

* M — Mechanical. H — Hand. M-S — Mechanical Sandwich, See Fig. 3.
NOTE: All tests were made on water-tube boilers.

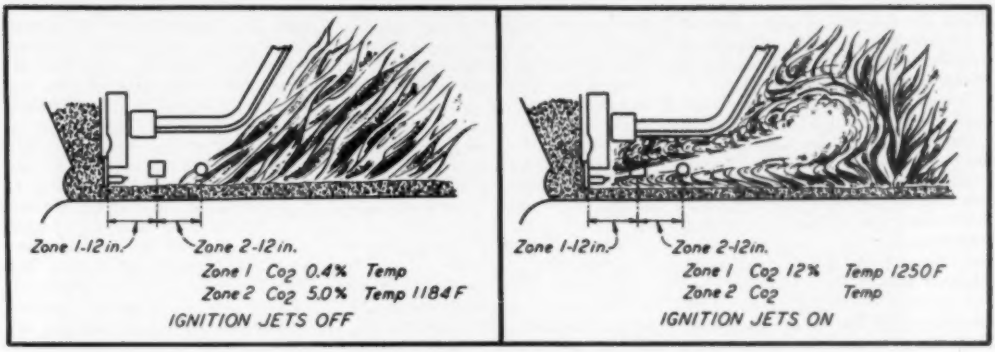



**Fig. 1—One of the difficulties in burning low-grade fuels is maintenance of ignition near front end of grates. Use of steam jets help to overcome it**

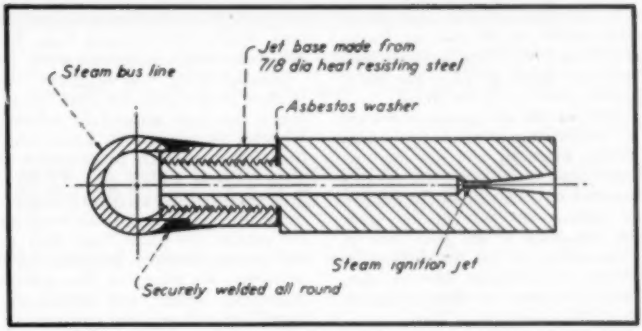

Steam bus line
Jet base made from 7/8 dia heat resisting steel
Asbestos washer
Steam ignition jet
Securely welded all round

**Fig. 2—Type of steam jet used successfully to ignite low-grade types of fuel as soon as they enter the furnace**

present in the circulating water of the coal washing system. These particles are collected in settling ponds and water clarification plants. The characteristics of slurry vary considerably depending on the nature of the coal seams worked and the associated strata.

Column 2 in the table shows the performance of a plant burning a typical slurry. It is seen to consist of 39.2 per cent inerts with a moisture content of 25.3 per cent. This of course made it impossible to handle this fuel mechanically and provisions had to be made to charge it by hand on to the grates.

The optimum combustion rate was 35.3 lb per sq ft per hr, which gave a heat release of 280,000 Btu per sq ft per hr. Under these conditions the boiler generated 86 per cent of its rating but it was necessary to keep very careful control over combustion conditions.

In order to eliminate manual handling, it was necessary to upgrade the fuel by blending it with a graded coal and coke breeze to absorb the excessive moisture. Such a successful mixture consisted of 60 per cent bituminous pearls (¼ in.), 20 per cent coke breeze, and 20 per cent slurry.

*Filter Cake*—Thickened slurry from a flocculation plant can be filtered on rotary vacuum filters and the solid product burned as filter cake. Such a fuel and its performance is shown in column 3 in the table. It is seen to be similar to the slurry previously described except that its calorific value is higher. The boiler itself was of standard water-tube design.

The grate area was increased to allow for reduced heat release, a rear arch was added and the front arch extended towards the front to provide a preignition or drying zone. The fuel was delivered to a firing platform from where it was charged by hand on to the chain grate.

Combustion rate was 20 per cent lower than for the plant reported in column 2, but in spite of that the evaporation was 33 per cent in excess of that originally estimated with this fuel. Satisfactory operation has been maintained for a number of years. An important factor controlling performance was the moisture content. It was found that it had to be kept below 25 per cent; any small increase above this limit caused operating trouble.

*Coke Breeze*—Column 4 shows data and results for a plant handling coke breeze. This breeze was obtained from the screening plant of a gas works and consisted of 75.6 per cent fines through ⅛ in. screen. It contained 18.4 per cent moisture and 12.1 per cent ash. Coke breeze, due to its porous nature, has a greater ability than fine coal to absorb moisture and it was therefore possible to handle this fuel mechanically. Compartment type stokers were provided to adjust air distribution and combustion rates of 276,000 Btu per sq ft per hr were maintained without difficulty. Average $CO_2$ content in the exit gases was 10 per cent. An important factor contributing towards the successful operation was the design of the ignition arch upon which the breeze depends for efficient ignition.

## Aids to Combustion

The foregoing data prove that such fuels can be burned successfully provided the boilers and combustion equipment are designed accordingly. In many cases, however, it is not possible to carry out major alterations to a plant designed originally for graded fuels. Provided sufficient air pressure is available most fuels can be burned, but as explained previously there usually is associated with it a drop in evaporation.

One of the greatest difficulties in the burning of such fuels is the maintenance of ignition at a point sufficiently near the front end of the grate to allow complete combustion of a sufficient weight of fuel. A considerable length

of the grate is often taken up for drying the fuel so that only a portion is available for combustion. This means a further drop in the total furnace heat release and therefore steam output.

Several methods have been developed to counteract this effect, the most successful of which are described below:

*Steam Jets* — In this system, a steam line is mounted horizontally across the boiler front and attached to the coal feed shutter so that it retains its position relative to the top of the fuel bed whatever the thickness may be — see Fig. 1. Steam jets, Fig. 2, are mounted on this supply line, 4-in. apart, with their axes parallel to the line of travel of the chain-grate and above the fuel bed. The main steam pipe is mounted in U-clamps in such a way that the jet angle relative to the coal may be altered from 0 to 35 deg. upwards from horizontal. Steam is fed to the jets at pressure between 15 and 40 psi.

Some of the air present above the fuel bed becomes entrained by the high velocity steam jet and the local reduced pressure in the vicinity causes a backward travel of the hot gases from the incandescent part of the grate. This movement of hot gases fixes ignition within the first few feet of the furnace, and provides effective combustion area over the whole surface of the grate.

In one case where such jets were used, boiler was rated at 50,000 lb per hr. for a 1½ in-washed slack generating steam at 355 psi and 645 F. It was burning slurry of 8800 Btu per lb and evaporation without the jets did not exceed 40,800 lb per hr. With the jets on, evaporation was raised to 56,520 lb per hr with a $CO_2$ of 12.5%.

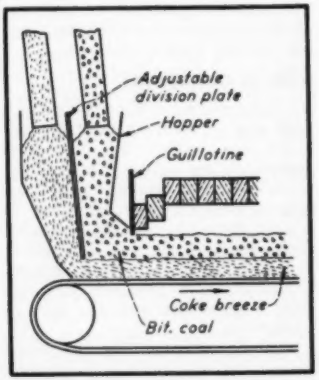



***Fig. 3—Adjustable division plate fitted in coal hopper sandwiches the low-grade coke breeze between upper layer of coal and the grate surface***

*Oil Spray* — Another successful system termed "assisted firing" employs a series of steam atomized oil burners. These are placed in the secondary air ports at the front arch of the boiler and are set to spray at an almost vertical angle downwards against the fuel bed. The function of the oil spray system is not merely the provision of additional heat but the maintenance of a high temperature ignition zone at the front end of the grate. The ultimate effect is similar to that of the steam jet but is more effective.

The boiler in question was set up to burn 40 per cent coke breeze and 60 per cent slack with a sandwich fire. The oil spray system enabled 100 per cent of coke breeze to be burned. Furthermore, evaporation under the sandwich system did not exceed 85 per cent, whereas with assisted firing the full steam output could be met.

Assisted firing was originally developed at this plant for coke breeze, but it has been successfully adapted for other plants and fuels where it has been found necessary or profitable to convert to low grades.

*Sandwich Firing* — In order to increase combustion rates when handling low-volatile low-grade fuels such as coke breeze, sandwich firing has been developed. By means of this system, chain-grate stokers and boilers designed for 100 per cent coal may be adapted to use a proportion of coke breeze depending on load and draft available.

An adjustable division plate is fitted into the coal hopper at the front of the boiler, as shown in Fig. 3. Coal and coke breeze are separated in such a way that the breeze is sandwiched between the grate and an upper layer of coal slack. Typical results of a small water-tube boiler are shown in column 5 of the table; it is seen that with a 70-30 mixture of slack and breeze, a combustion rate of 360,000 Btu per sq ft per hr was obtained giving 100 per cent evaporation.

The capital outlay for this alteration to an existing plant is considerable, but is has proved economical and in times of need invaluable.

## Special Problems

*1. Coal Handling*—The range of size distribution may cause segregation which results in uneven burning on the grate. High moisture content is liable to cause bridging or sticking in conveyer and coal chutes. In certain cases of excessive moisture content this may be so serious as to necessitate hand-feeding of the grate.

*2. Type of Grate* — The type of grate needs very special consideration. A grate designed to handle graded coal will work inefficiently with low-grade fines due to the high loss through the air spaces. Most chain or travelling grate stokers, however, have been designed for a wide range of sizes and they are predominantly used in Britain for the combustion of low-grade fuels.

Compartment type stokers are a help towards distributing the air over the full length of the grate according to fuel distribution and burning behavior.

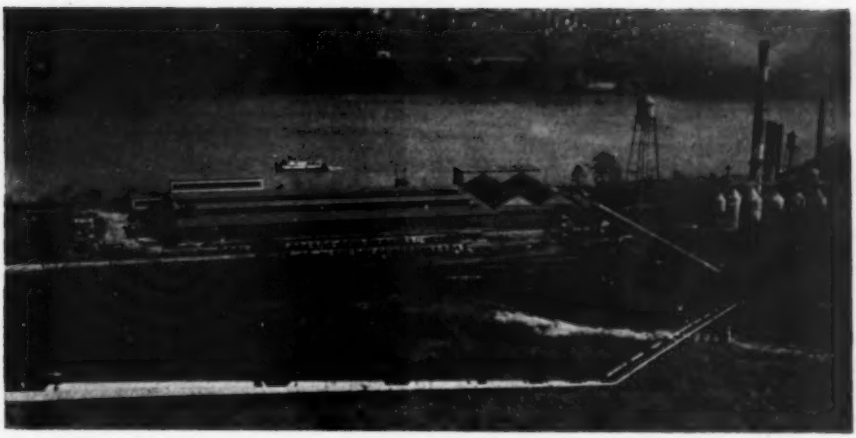
*3. Thickness of Bed*—The firebed thickness depends on burning characteristics and method of feeding. The lower the grade of fuel the greater the thickness required to maintain ignition. Correspondingly higher pressures are needed under the grate. It must be clearly realized that the volume of air required is a function of combustion rate and combustion efficiency only, whereas the pressure depends on fuel bed resistances. In other words, the volumes of air and gases will usually remain the same or be reduced when burning such fuels, whereas the undergrate pressure must be increased due to the increased firebed thickness.

*4. Ignition* — Maintenance of ignition is a pre-requisite to satisfactory operation. The length of front and rear arches are of fundamental importance. With high-moisture coal, a long front arch is desirable to provide a drying (or pre-ignition) zone. Modern trend has been the provision of rear arches to radiate heat to the fuel bed, particularly for anthracites. Low-grade fuels require careful balancing of these considerations. Where the furnace was originally designed for high-grade fuels, special means may be resorted to for maintaining ignition when changing to lower grades. (These are discussed below.)

*5. Burning Rate* — The maximum burning rate of a chain grate stoker is limited by the maximum air pressure which will keep the fuel bed on the grate. When burning fuels which contain a large percentage of fines, the limit is set by the maximum allowable grit emission determined by loss of efficiency and considerations of atmospheric contamination. Combustion rate (lb per sq ft per hr) must be lowered and, due to the lower calorific value, there follows a very considerable drop in the rate of heat release (Btu per sq ft per hr). If, in addition, ignition cannot be maintained near the front end of the grate, it means that the effective grate area is reduced, diminishing further the total heat release.

*6. Grit Emission* — Grit emission is a very serious problem connected with the use of low-grade fuels. Most of them contain a large percentage of fines below ⅛ in. which are easily

***( Continued on page 117 )***



*Water used in grinding and polishing plate glass at Creighton, Pa., no longer pollutes the Allegheny with its entrained abrasive powders. After settling, the sludge is pumped through the pipeline in the foreground, over a 320 ft hill and to a lagoon a mile away. Only clear water is returned to the river*

# DISPOSING OF ABRASIVE WASTES

**PAUL D. OESTERLE,** *Application Engineer, Dravo Corporation*

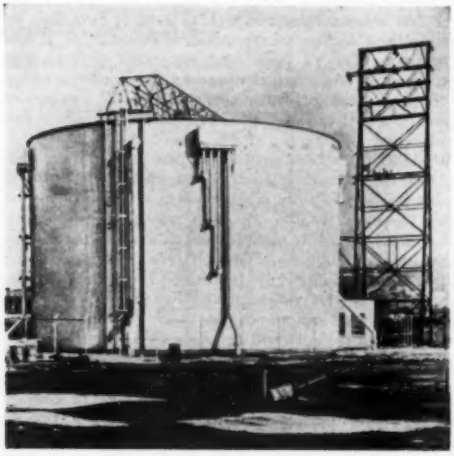
DISPOSAL of several hundred tons daily of a highly abrasive waste product from the grinding and polishing of plate glass confronted the Pittsburgh Plate Glass Company in its program of cooperation to clean up Pennsylvania's streams.

Grinding and polishing plate glass at the Creighton, Pa., plant produces several thousand gallons per minute of water mixed with powdered glass, fine silica sand, emery, rouges, plaster of paris, and a small amount of powdered iron. To make a mixture more abrasive than this probably would require diamond dust.

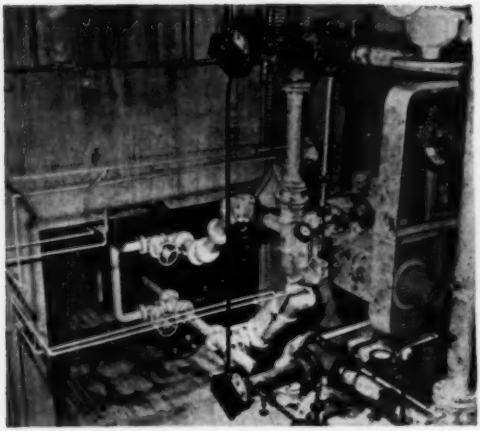
Until early last summer, the effluent flowed into the Allegheny River, from which the settled solids were dredged periodically and loaded into barges for disposal. With emphasis on clean streams, the glass firm called in The Rust Engineering Company to design and build a disposal system that would not pollute the river with the waste.

A thickener, into which is pumped the abrasive water from the plant's industrial sewer, was installed. After passing through this unit, the water has a turbidity of less than 100 ppm—almost crystal-clear water—and flows into the Allegheny. Underflow from the bottom of the thickener, a slurry with a concentration of one-third abrasive materials, is pumped through a mile-long pipeline, over a 320 ft hill, and into a settling basin formed by damming a 700-1600 ft natural hollow. Total clearwater head overcome on the system is equal to 530 ft. Solids settle out in the basin, and the remaining clear water eventually will overflow into a creek that empties into the river.

Biggest problem in building this waste disposal system was in pumping 230 gpm of the thick, abrasive sludge over a hill and to the basin a mile away. The powdered glass, fine silica sand, and plaster of paris would quickly wear out the metal plates, impellers, and other parts of ordinary pumps. Also important, the sludge would leak back through the clearance between the rotating impeller and the stationary side plate and into the stuffing box where



***Abrasive solids are separated from most of the water in this thickener. The clear water with less than 100 ppm of solids is drained to the river. Solids settle to the bottom of the thickener and pumps, built for abrasive liquids, discharge the slurry to a lagoon. Mixture as pumped consists of one third solids***



*Two rubber-lined, 230 gpm slurry pumps in series discharge the abrasive mixture into pipe line. High-pressure clear water between impeller and case protects stuffing boxes*

*Six pumps in series are required to raise waste to this settling basin made by damming a natural hollow. Solids settle and clear water will eventually overflow to creek*

it would very quickly wear the shaft.

In solving these problems, Dravo Corporation assisted in design and construction of the pumping part of the disposal system. Six pumps, manufactured for handling abrasive liquids, were used. All surfaces that come in contact with the solution being pumped are made of rubber, which outlasts equivalent metal parts four to six times. Leakage of the abrasive slurry into the stuffing box is eliminated by the design. A very small quantity of clear, abrasive-free water is introduced into the clearances between the rotating impeller and the stationary side plate of the pump at a pressure slightly higher than the pump discharge.

Two pumps were installed in series at the thickener, and two each, also in series, in two booster stations along the line of 4 in. extra-heavy steel pipe line. All pumps, V-belt drives, and motors are identical to permit the interchange of parts and to hold stocking of spare parts to a minimum.

Reversal of sludge flow through the pumps in case of a mechanical or electrical failure could cause serious damage to the system. Anticipating this possibility, the engineers installed a duplicate complete stand-by pumping system to take over automatically in case of failure. In the event of a complete power failure so that the stand-by system could not operate, air-operated dumping valves were installed to discharge the sludge into a small emergency lagoon provided for the purpose.

## Engineers Delve Deeper Into Corrosion At High Temperatures

• A quantity of information on the corrosive effects of various hot environments has been accumulated by the Development and Research Div. of The International Nickel Co., Inc. This has involved a continuing and expanding program designed to evaluate the corrosion resistance at high temperature of different metals and alloys for such specific applications as are encountered in the aviation, petroleum, chemical processing, heat treating, and other fields, especially those producing equipment and supplies for the defense program.

There is still a great deal to be learned about high-temperature corrosion, not only with respect to some of the underlying principles governing surface reactions, but also from the practical aspect as to means of eliminating or minimizing corrosion damage by selection of appropriate alloys. As operating temperatures in many industries continue to increase, it is inevitable that high-temperature corrosion problems should multiply on a cumulative basis.

Studies are being accelerated tremendously by the defense program, which involves not only military and naval equipment and supplies, but processes by which material of all kinds are produced.

Considerable data on the creep and rupture characteristics of materials at temperatures up to and including 1800 F, and some data at temperatures as high as 2100 F, have been secured in the Company's Laboratories at Bayonne, N. J., and Huntington, West Va. In addition, test spools, or racks, have been installed under actual operating conditions in industry. Each of these spools contains specimens of a variety of alloys and a comparison of their performance is made at frequent periods of time.

While strength characteristics are unquestionnably important, Inco engineers emphasize that to achieve long life and trouble-free service in high temperature environments, it is usually necessary to place governing importance on the corrosion behavior. This fact has been further confirmed by information on high-temperature corrosion mechanisms studied at the Bayonne and Huntington Laboratories and by engineers of the Development and Research Division. Information already secured has been made available to industry and additional data will be provided as developed.

The Development and Research Div. is prepared to offer assistance and information on specific high-temperature problems and will shortly circulate a work sheet to simplify the gathering of pertinent information for examination by Inco engineers.

# AN APPROACH TO PIPING DESIGN

**ROBERT H. EMERICK, *Consulting Mechanical Engineer***

**A good start in designing a piping system is to secure all the codes covering metal specifications to fit the job. From there on it is a simple matter to determine pipe size with equations in this article**

A PIPING SYSTEM is no stronger than its weakest material. By extension it also emphasizes the first law of piping design, which tells us to consult applicable codes before choosing the material for our project.

There are nine codes issued by associations alone. Each, of course, deals with some specific activity, the American Gas Association being concerned with design in the gas business, the American Petroleum Institute is the guiding authority for oil men, and so on. Some overlapping is inevitable, but with so many anxious monitors at hand, a failed line is almost certainly our own fault. We should use the codes, and the local and insurance piping system regulations as well.

Each code is a growing, changing thing, consequently we must keep up with the latest revisions for both safety and economy of design. For instance, the basic Code for Pressure Piping issued by the ASME told us that nuts cut from bar stock with their axes parallel to the direction of rolling of the bar should not be used except for sizes smaller than ½ inch. A later revision made such nuts acceptable for cast iron flanges in all sizes, but continued to prohibit their application to steel flanges except in the smaller than ½ in. size.

Materials must be judged from the standpoint of environment. For example, one day in an oil refinery, a cast iron elbow on a hot oil line cracked wide open; it had no right to be in such service in the first place. The escaping oil flashed at once, and in a moment the entire building was engulfed in flames. This provided a most uncomfortable situation for neighboring pipelines; those having combustible gaskets in their joints faced prompt disintegration.

As a result of such happenings, the Code for Pressure Piping now states: "Gasket material for piping operating at a temperature over 250 F, or for piping adjacent to a hot-oil line, shall be metallic, asbestos, or other non-combustible material."

### High Temperature Gaskets

The code then proceeds to state that conventional compressed asbestos gaskets should not be used for temperatures over 750 F, especially if the pressure is above 450 psig. For these high-pressure, high-temperature jobs, either all metallic or asbestos-filled gaskets, are recommended.

Just to emphasize the uncertain relationship of cast iron to hot oil and the influence of environment, the pressure-piping code informs us to avoid the installation of cast iron valves and fittings on *cold* oil lines if they are located in the vicinity of hot equipment or hot piping. In short, the codes provide pain saving short cuts to the selection of safe materials.

*Designing for Size.* Our first step in sizing a pipeline is to determine the pressure drop permissible. The larger the drop, the smaller becomes the pipe we can use, and the smaller the pipe the lower the cost. Designers frequently are able to size a line so a pressure-reducing valve at the delivery end is eliminated.

Knowing the pressure drop, we have a choice of equations by which to decide piping diameter. The box contains some in common use, not a complete list, and possibly not always presented in the same arrangement of symbols.

The Hazen and Williams formula for flow of water in pipes, will not be discussed here, since it has been converted into tables available in almost every standard handbook. We might note, however, that the Hazen and Williams equation does not include a friction factor, a characteristic that makes it unsuitable for many other

**TABLE OF STEAM VISCOSITY VALUES**

**Compiled from data developed by Hawkins, Solberg & Porter at Purdue University.**

| Pressure, psia | Sat. temp, F | Viscosity* | Viscosity* with superheat 50 F | 100 F |
|---|---|---|---|---|
| 100 | 327.81 | .0176 | .0182 | .0191 |
| 200 | 381.79 | .0202 | .0208 | .0211 |
| 300 | 417.33 | .0216 | .0221 | .0225 |
| 400 | 444.59 | .0224 | .0232 | .0239 |
| 500 | 467.01 | .0242 | .0248 | .0250 |
| 1000 | 544.61 | .0282 | .0288 | .0292 |

*Absolute viscosity in centipoises.

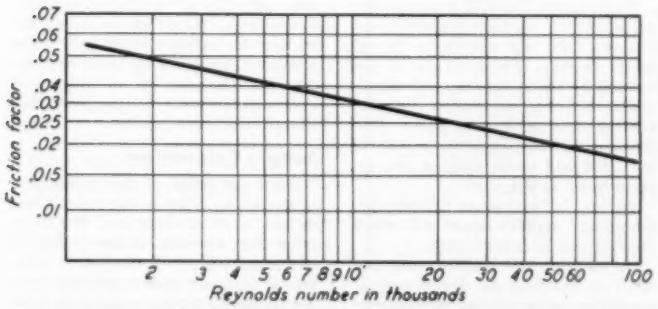



***Fig. 1—All Reynolds Number graphs are not alike because the numbers themselves are not alike. You can make up your own numbers by using unit values in equation 5***

**EQUATIONS FOR DETERMINING PIPE DIAMETERS**

(1) A general flow equation used for steam and fluids, particularly the former:

$$P_1 - P_2 = \frac{.01214 \times f \times v \times W^2}{d^5}$$

Where: $P_1 - P_2$, pressure drop, psi per foot of pipe
f, friction factor, developed from the Reynolds Number
v, specific volume in cu ft per lb
W, flow, in lb per minute
d, inside diameter of pipe, inches

(2) The Fanning Equation, quite similar to the previous one, and recommended for any of the common industrial fluids:

$$h_L = \frac{f \times L \times v^2}{2 \times g \times D}$$

Where: $h_L$, loss of static head expressed in feet of fluid
f, friction factor, developed from Reynolds Number
L, length of pipe, in feet
v, mean velocity of flow, in fps
g, acceleration of gravity, 32.2
D, internal diameter of pipe, feet

(3) The Harris Equation for compressed air:

$$D = \frac{.1825 \times L \times Q^2}{r \times d^{5.31}}$$

Where: D, pressure drop in psi
L, length of pipe, feet
Q, cu ft of free air per second
r, ratio of compression at pipe entrance
d, internal diameter of pipe, inches

(4) The Oliphant Equation for natural gas piping:

$$Q = 1008 \times d^{2.643} \sqrt{\frac{P_1^2 - P_2^2}{L}}$$

Where: Q, cu ft per 24 hr, measured under the conditions of absolute temperature and absolute pressure at the point of delivery
$P_1$, absolute pressure, psi, at the inlet end of pipe
$P_2$, absolute pressure, psi, at delivery end of pipe
L, length of pipe in miles

(5) $R = \frac{D \times v \times p}{u}$

Where: R, Reynolds Number
D, diameter of the pipe
v, velocity of flow
p, density of the fluid
u, absolute viscosity of the fluid

(6) $v = 0.22 \times S \times U$ minus $\left(\frac{180 \times 5}{U}\right)$

Where: u, absolute viscosity in centipoises
U, seconds, Saybolt Universal
S, specific gravity at the existing conditions

(7) Kinematic Viscosity $= 0.219 \times t$ minus $\left(\frac{149.7}{t}\right)$

Where: t, seconds Saybolt

fluids, particularly oils.

*The Reynolds Number.* Back in 1874, Professor Osborne Reynolds proposed that we incorporate all the factors affecting friction flow in piping, into a single unit of relationship, thereby making pipe calculations much easier. This unit, which ties together surface roughness, viscosity of the fluid, and velocity of flow is now called the "Reynolds Number."

Professor Reynolds further told us that friction is affected by the state of flow, meaning whether it is turbulent or moving along smoothly and calmly. The former condition results in smaller friction loss, and if our design predisposes toward turbulence we will know it from the size of the Reynolds Number, the larger numbers usually indicating the turbulent zone, a desirable condition.

## Use of Reynolds Numbers

There is, of course, an intermediate range of numbers in which the flow can be either turbulent or smooth. When in doubt, always use turbulent values; we can't stretch a too-small pipe to reduce friction.

To transfer Reynolds Numbers into the usable form of friction factor for duty in the pressure-drop equations, we must refer to a graph such as that in Fig. 1. All Reynolds Number graphs are not alike because the numbers themselves are not alike. We can make up our own Reynolds Numbers if we desire by using whatever unit values we wish in equation 5.

For instance, we can use the pipe diameter "D" in feet, inches, or centimeters; the velocity in feet per second or centimeters per second; the density in pounds per cubic foot or grams per cubic centimeter; the viscosity in pounds per foot second, or centipoises. Some designers even mix up these units, with their feet, inches and centipoises all in the same equation, a practice that probably is not desirable, but from reports, it seems to work.

## Solving Equation

To solve the Reynolds Equation and get a number, we must assume a pipe diameter, and then determine the absolute viscosity. The latter can be discovered by laboratory tests and experiments, but most of us will find exercising equation 6 much easier. This absolute viscosity equation is offered by Crane and is the shortest one apparently on record.

Nelson, in "Petroleum Refinery Engineering," suggests equation 7, which requires one additional step.

In starting any journey, and certainly in traveling the design road of a pipeline, we should know where we are going and why. The steps in this sizing venture then are:

(a) Determine the pressure drop permissible.

(b) Set down the equation we adopt for the job, inserting all known values.

(c) Discover the friction factor by way of these corridors to the Reynolds Number: (1) Assume a likely pipe diameter, (2) Calculate the absolute viscosity of the fluid flowing, using the Saybolt values in seconds, (3) Substitute the now known numbers for the symbols in the Reynolds Number equation, and (4) With the Reynolds Number so developed, consult friction chart and read the friction factor.

(d) Insert the friction factor in the basic equation and solve for the pressure drop.

(e) Figure the pressure drop for the whole line, adding the drops through valves and fittings. These latter are readily obtainable from published charts and tables, of which no two, incidently, are exactly alike. Results always seem to be different with different experimenters, but these differences generally are within the limits of practical tolerance.

(f) If the total drop is allowable, the job is done; if too great or too small, then we must start all over again..

Obviously, the only more or less vague tool in this procedure, is the Reynolds Number friction graph. We can develop one for ourselves if we are so minded, but a much easier expedient is to choose a standard graph, such as the Pigott and Kemler presentation in Crane's "Flow of Fluids Through Valves, Fittings and Pipe," Technical Paper No. 409. No less than 18 curves appear on this graph, representing friction factors for pipe with various degrees of roughness.

Alternatively, Unwin offers a readily workable graph in "Piping for Industrial Fuels," published by Heating and Ventilating. The Unwin graph does not include a correction for pipe-surface roughness, consequently this step must be taken separately. Unwin suggests an average roughness multiplier of 1.25, thus increasing the friction factor by 25 per cent. The allowance for growing corrosion and roughness is a matter of judgement on the part of the designer; over-optimistic designers beware.

## Sample Calculations

Since the proof of any pudding is in the eating, suppose we try out one or two of these equations. We'll assume that we must deliver 4,200 lb of steam per hour through a pipe 100 ft long and with a pressure drop not to exceed 50 psi, starting with an initial pressure of 100 psia.

According to the steam tables, our

100-psia steam will occupy 4.432 cu ft per lb, have a density of 1/4.432 or 0.225, and will be flowing at the rate of 4,200/3,600 or 1.17 lb (approx.) per sec.

For our first guess, we will calculate the drop through a 3 in. pipe, using this figure in our pursuit of the Reynolds Number, equation (5).

$$R\ N = \frac{3 \times 101.1 \times 0.225}{0.0176} = 3,877$$

The velocity figure of 101.1 ft. per sec will be obtained by multiplying first the volume per pound of 4.432, by the weight flowing per second, 1.17, to show the total volume per second of 5.185 cu ft, and then by dividing this by the cross-sectional area of the 3 in. pipe in square feet, which happens to be 0.0513. The absolute viscosity of the steam at 100 psia saturated is shown in the steam viscosity table.

If we now refer to the typical friction-factor chart, Fig. 1, reading the curve at a Reynolds Number of 3,877, we come up with a factor of 0.042.

The next step in this long march to a pressure drop requires us to solve the basic equation, and we will try out the general flow equation (1):

$$P_1 - P_2 = \frac{0.01214 \times .042 \times 4.432 \times 4900 \times 100}{243}$$

$$P_1 - P_2 = 4.57 \text{ psi approx.}$$

This is a small drop, considering that up to 50 psi is permissible, so in real life we would try again, using a smaller pipe, perhaps 1½ in.

Incidentally, if we want to make our own friction graph, we can start with one of the following equations for the viscous, or streamline flow area:

$$f = 0.00267 \times \text{Reynolds Number.}$$

$$\text{Or, } f = 64/\text{Reynolds Number.}$$

These equations are valid for Reynolds Numbers up to about 1,200. If the number is larger than 1,200, we had best consider it in the turbulent-flow region, and modify the friction factor by a correction for surface roughness before placing the (f) on the graph. What this modification amounts to, as we have noted before, is largely a matter of judgement. Generally we can expect that in new pipe, the roughness factor will vary from say 5 per cent up to 40 per cent.

Note *Part 2, to appear in an early issue, will cover design factors that must consider installation problems.*

# What to do until the doctor comes

***Emergency methods that may keep your equipment running after a breakdown until the permanent repairs are made***

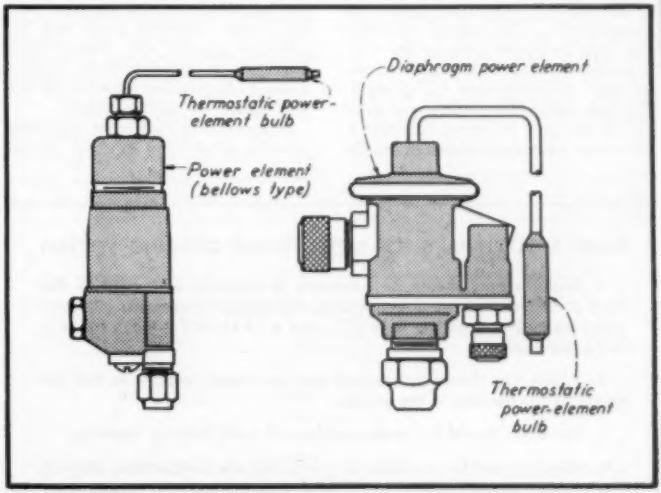
## Emergency Recharging of Thermostatic Expansion Valve Power Elements

• Thermostatic power elements depend upon the amount of refrigerant in them for accurate operation. It is possible to recharge a power element in any shop. A hole should be drilled in the bulb, and the temperature of the entire element lowered slightly below the boiling point of the refrigerant used. After feeding some liquid refrigerant into the power element through the hole drilled in the bulb, it should be quickly soldered shut. The hole should be approximately ⅛ in. in diameter and the liquid may be fed through it with an eye dropper. Recharging of these bulbs should be undertaken only in cases of emergency or for experimentation. Every manufacturer has developed his own method of charging elements accurately. Such methods include temperature control, pressure control, and volume control.

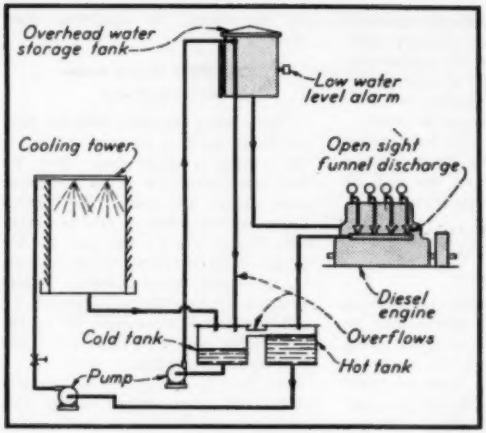
The way to test a power element for partial discharge is to lower the temperature of the diaphragm or bellows portion to about 30 F, and then heat the bulb to a temperature of about 40 F. Under this condition the bellows or the diaphragm should be flexed outward. If the bellows or diaphragm does not flex outward or yield itself readily to the pressure of the fingers, the power element should be replaced.

The thermostatic expansion valve is designed around the charge in the power element. To attempt to *accurately* recharge it would require not only expensive equipment, but certain knowledge that is in many instances regarded by the manufacturer as secret. Inoperative, discharged or partially discharged power elements should be returned to the factory for repair or replacement as soon as possible.

Courtesy of The Refrigeration Serviceman's Manual.




***Both types of thermostatic expansion valves for refrigeration depend on amount of liquid refrigerant in the bulb. In emergencies, this can be temporarily refilled***



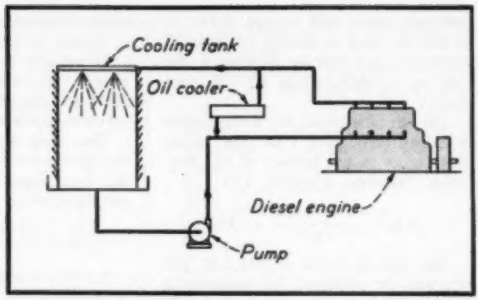




**Fig. 1 (left)—In open type systems, water is recirculated over cooling tower. Overhead tank insures ample supply of water. Temperature control is provided by throttling valve**

**Fig. 2 (above)—Simplest open system has no overhead storage and it must have protection against water circulation failure. It is often used on the smaller diesel engines**

# COOLING SYSTEM LAYOUTS FOR BEST DIESEL PERFORMANCE

**These arrangements, and features described in conjunction with them, will help select the system best suited to the application**

**A. O. STAC', Cooling Equipment Division, Binks Manufacturing Company**

A general knowledge of the various flow diagrams commonly used for cooling engines will help select the proper cooling tower and heat exchange coils. The amount of heat that must be carried away by the cooling water is in most cases greater than the heat converted into useful work. For that reason, the cooling system is one of the most important features of the power plant, and its design should receive careful engineering attention.

In general, the two types are the open and the closed cooling water systems. Each will be discussed, and typical flow diagrams given, with the principal merits and disadvantages described. By a study of these diagrams it should be possible to select the one best suited for any installation.

Often cooling equipment is entirely adequate in size and capacity, yet because of poor design on flow diagram, pumping arrangement, restricted piping, or any other one of many faults, the system is not satisfactory as a whole. Frequently, the cooling equipment is blamed for the whole trouble.

**BASIC REQUIREMENTS FOR DIESEL ENGINE COOLING SYSTEMS**

1. Water supply should be adequate in quantity, so that under full load conditions maximum temperature difference between the inlet and outlet water should not be over 20 F, and a 15 to 18 F cooling range is to be preferred.

2. Water flow should be constant and at uniform velocity, so that hot spots will not develop in the engine.

3. The water should be clean and free of scale forming hardness.

4. Means should be provided for controlling the temperature, keeping it relatively constant regardless of load and atmospheric temperature.

## Open Type Systems

In an open cooling system, the water which flows through the engine jackets is then discharged directly to waste, or circulated over a cooling tower and returned to the engine. Discharging to waste is seldon feasible because of high cost of water and difficulty of obtaining suitable quality. Most natural water contains enough hardness so any continual use leads to heavy scale deposits in engine jackets. Temperature is too low for efficient engine operation. If flow is restricted by means of thermostatically controlled discharged valves, temperature rise becomes too great, often as much as 60 F, and results in uneven cooling, hot spots, steam pockets and other troubles.

The open system where the water is recirculated over a cooling tower is often used, especially on low power engines, or for engines which operate

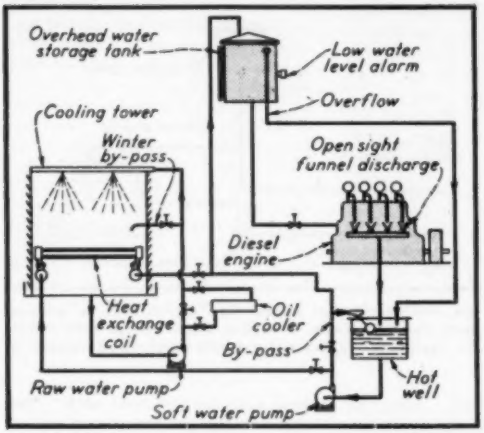



**Fig. 3—A complete, closed type evaporative cooling system with all features for good cooling. There is an adequate supply of controlled temperature, deposit free water**

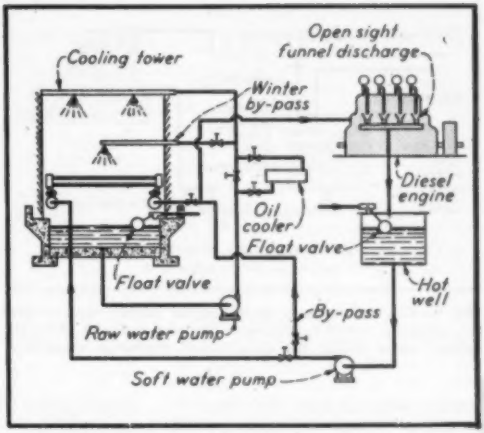



**Fig. 4—This is the same system shown in Fig. 3 with the overhead storage eliminated. It is less expensive but needs water failure protection and permits danger of air pockets**

for short periods of time. The only advantage of this system is low first cost. All basic requirements except No. 3 are satisfied. Where natural water is very soft, this system is completely satisfactory.

In most localities the natural water contains varying quantities of hardness, and even though only a small amount of water is needed for makeup purposes, amount of scale introduced into the engines by this means is still so large as to be a source of serious trouble.

Even if the water is relatively soft, accumulation of scale deposit may be very large. Total amount of hardness added to a cooling system by the make-up water is much larger than usually believed. For example, on a 1000 hp engine with a heat dissipation of 3,000,000 Btu per hour, and a water circulation of 400 gpm, the cooling range would be 15 F. Loss of water through evaporation in any type of cooling tower would be 1.1 per cent or 4.4 gpm. The table will show the total amount of hardness added to the system by the makeup. Since only pure water is evaporated, that remaining in the system becomes progressively harder.

The table does not show hardness added by make-up added to replace water lost through driftage. On most open type designs, water in the system remains at about constant hardness which is usually greater than that of the makeup water. Some hardness added by evaporated water is lost by driftage. The largest part is deposited in the engine jackets as scale.

In spite of obvious disadvantages, the open type cooling system is often used. Fig. 1 gives the recommended arrangement of the equipment for the most desirable operating conditions. Use of the overhead storage tank makes certain that the engine will be supplied with an ample quantity of water.

Temperature control is obtained by regulating the flow of water over the cooling tower. The throttling valve shown is one of the most common methods used. As flow to the tower is restricted, the warm water overflows from the hot to the cold tank, tempering the water as needed.

## Tower Capacity

Cooling towers for open systems should be heavily overloaded as to capacity. Since high efficiency is not required, nor even desired, much more satisfactory results are obtained by selecting towers for 50 to 100 per cent more than standard rating. Amount of overloading depends on the temperatures which are desired. For any temperatures higher than 130 F out of the engine, and with cooling range of 20 F it is safe to double normal capacity.

Fig. 2 shows the simplest system. It is used on small diesel engines, cotton gins, small industrial drives, and is the cheapest to install. The arrangement meets only the first two of the basic requirements. Control of temperature is difficult, there is increased danger of forming air pockets in the engine jackets and because there is no reserve of water above the engine, any interruption of the pump stops the supply to the engine, a most dangerous condition. When using the system it is advisable to install devices that automatically cut the engine fuel supply when water pressure at the engine falls below a certain point.

There are many possible variations of open type cooling systems, but since basic principles are so simple, it is usually not difficult to lay out a system for a specific application. Open type designs should be avoided wherever possible and the closed type, with all of its many advantages should be used.

## Closed Type Systems

Whenever natural water is not sufficiently soft to satisfy the third basic requirement, some form of closed type

**INCREASE IN MINERAL HARDNESS ADDED BY MAKEUP WATER**

| Hardness of makeup grains per gal | Classification of makeup | Mineral hardness added lb per month |
|---|---|---|
| 5 | Very soft | 134 |
| 7½ | Soft | 201 |
| 10 | Average | 268 |
| 15 | Moderately hard | 403 |
| 20 | Hard | 537 |
| 25 | Very hard | 671 |
| 30 | Extremely hard | 806 |

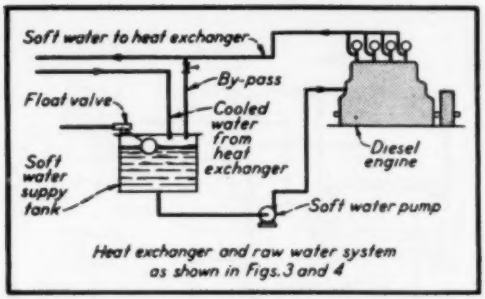

Soft water to heat exchanger
By-pass
Float valve
Cooled water from heat exchanger
Diesel engine
Soft water supply tank
Soft water pump
Heat exchanger and raw water system as shown in Figs. 3 and 4

**Fig. 5—Cooled water is stored in the supply tank in this arrangement, which is otherwise like that in Fig. 4. Pumped jacket water makes the open funnel discharge impossible**

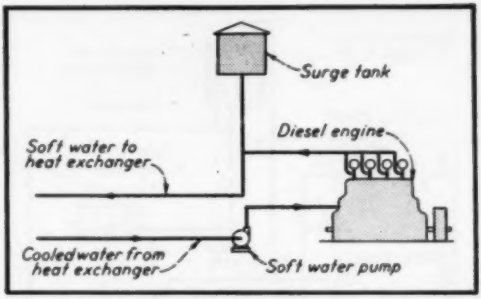



**Fig. 6—The simplest closed type system uses no storage tank, has a minimum of cooling water. Surge tank allows for expansion. Jacket water supply protection is necessary**

cooling system is used. Soft water is circulated through the engine jackets and then through a heat exchanger, where it is cooled, and recirculated through the engine. Since the engine cooling water is used over and over again, and the makeup is negligible, specially treated or distilled water can be used, completely eliminating any scale formation in the engine.

Some form of closed type cooling system is universally recommended by all diesel engine manufacturers, power engineers, and all insurance companies.

There are three major types of closed cooling systems:

1. The open evaporative heat exchange coil.
2. The shell-and-tube type of heat exchanger.
3. Air cooled radiators.

## Evaporative Systems

Engine jacket cooling water is passed through open type heat exchangers installed in a standard cooling tower. The heat exchange coils are cooled by the raw water which is sprayed downward onto them. A substantial part of the heat is dissipated by the direct evaporation of raw water on the surface of the heat exchanger tubes. The balance is transferred by direct conduction to the raw water as it flows over the tubes. The raw water, in turn, is cooled as it falls through the tower before striking the tubes.

A closed type evaporative system which embodies all of the essential and recommended features of a perfect engine cooling system is shown in Fig. 3. A liberal and steady flow of water through the engine jackets is constantly circulated. Temperature of the water leaving the engine can be held at a constant figure, regardless of load, so that the engine is always adequately and efficiently cooled. Since all danger of scale formation is eliminated, the engine may operate at much higher water temperatures, increasing overall engine efficiency. Temperatures of 160 F leaving the engine are commonly used, and some of the later engines are designed for a leaving temperature of 190 F.

In the closed system as shown in Fig. 3, a supply of water is carried in the overhead water storage tank of large capacity. For most normal installations 25 gal per each gpm being circulated through the engine is satisfactory. For example, if 400 gpm are being circulated through a 1000 hp engine, the overhead storage tank should have about 10,000 gal capacity. Chief advantage of the large supply is that the engine can be operated for a reasonably long time, even if the water circulating pump should fail. Obviously, the size of the storage tank can be varied.

Since the engine is supplied by gravity head, (usually about 25 ft) the engine is always supplied with a constant and uniform volume at constant velocity. The open-funnel discharge allows the operator to visually check water flow and temperature.

The hot well should be of reasonable size—a minimum of 5 gal per gpm being circulated—is recommended. A float valve for making up the small water losses occuring is necessary.

The soft water circulating pump should preferably be installed in duplicate to insure safety of operation. An automatic water failure alarm, actuated by the pressure on the discharge side of the pump, is recommended.

## Heat Exchange Coils

Heat exchange coils are the heart of the system. Tubing that is self descaling, due to the expansion and contraction of the tubes, is recommended. Where scale forms so rapidly that the tubes do not descale themselves, it must be removed by manual scraping.

A by-pass connection should be provided so that soft water can be pumped directly to the overhead tank. This allows for temperature control during cold weather, or during periods when the engine load is very light.

## Cooling Tower Basin

The basin of the cooling tower should be deep enough to have reasonable protection from frost. Where a concrete basin is used, it should be at least 4 ft deep. Where the tower is installed on a roof, a separate raw water storage tank should be provided indoors in an area protected from frost. Raw water from the tower drains freely into the indoor tank. A float valve should be provided to automatically replenish the water lost by evaporation and driftage.

The raw water supply line to the cooling tower may be provided with a winter by-pass connection. This connects to a secondary manifold, located about midway between heat exchanger coils and top of the tower. The secondary manifold has fewer but larger nozzles, giving a coarser spray and shorter fall. During coldest weather, and when engine load is very light, the raw water pumps need not be operated at all, the soft water being sufficiently cooled by direct radiation to the cold surrounding air.

While the system as shown in Fig. 3 is the recommended arrangement, there are many variations which are often used.

The system in Fig. 4 is identical to Fig. 3 except that the overhead storage tank has been eliminated. There is no water supply in reserve and the engine must be immediately shut down if the soft water pump fails. There must be an automatic device to shut off the engine, preferably by stopping the fuel supply, when water supply to the engine fails. There also is some danger of forming air pockets in this arrangement, but in all other respects it has the advantages of Fig 3. Because of substantial saving in first cost, due to

the elimination of the expensive overhead storage, this system is common.

Fig. 5 shows a simple system essentially the same as Fig. 4. Soft water is pumped from the supply tank through the engine and then through the heat exchange coils before being returned to the tank. This has the advantage of keeping the contents of the supply tank cooler. Since the water is pumped through the engine, use of the open funnel discharge arrangement is not possible. Automatic safety devices to shut off the engine fuel when water supply fails should always be used.

Fig. 6 shows the simplest closed type cooling system. Water is continuously circulated without the use of any storage tank. The quantity contained in the system is at a minimum, and the engine cannot operate if the soft water pump shuts down. Automatic safety devices to shut off the engine fuel supply whenever the soft water supply fails, or becomes too hot, should always be used. The surge tank is necessary to take care of the expansion and contraction of the water.

Chief advantage is low first cost. The system is most frequently used on small engines and on engines used only intermittently.

In all sketches, the atmospheric cooling tower has been shown, but any type suited to the installation can be used with no change in piping circuits. All general arrangements in common use have been discussed, but there are many possible variations. As long as the basic features are satisfied, many changes can be made to best adapt the system to special features of any individual installation.

### Multiple Engine Cooling

When an installation contains more than one engine, a separate soft water pump for each is preferable. The heat exchange coils in the tower can be large enough to take care of all engines, but there is a definite advantage in flexibility of operation to keep a separate soft water circuit for each engine. On some large power plants, a battery of centrifugal pumps serve the soft water circuit, and the actual supply to each engine is controlled by individual valves. Chief advantage is that there is always a spare pump available and pumps can be used alternately.

On installations having a large number of engines, it is often desirable to divide the raw water circuit and the heat exchanger into several parts, arranged so that each part can be operated independently. This increases flexibility and simplifies temperature control under the varying load and atmospheric temperature conditions. Regardless of how the system is divided, the basic principles are the same.

### Shell and Tube Types

Shell and tube exchangers are economical where there is an ample supply of raw water, cheap enough to be wasted. Power plants located near natural bodies of water such as lakes and streams often use the system advantageously. When raw water has to be recirculated, it should be cooled in any standard type of cooling tower, selected according to the site available.

Cost of operation of the shell-and-tube system is higher than for the evaporative coil system. Total pumping head for both the soft and the raw water pumps is usually higher, and pressure drop through the exchanger is greater.

If raw water has to be circulated over the tower and then through the heat exchanger, which is often some distance from the tower, it is obvious that the pumping head will be considerably greater. Furthermore, raw water has to be recirculated continuously, while on the evaporative system, during cold weather or periods of light engine load, the raw water pumps need not be used and there is an average saving in cost of pumping.

### Air Cooled Radiators

When air cooled radiators are used, engine cooling water is circulated through a closed, fin type radiator, which in turn is fan cooled. The great majority of engines smaller than about 150 hp capacity usually use this system. Installation is more compact, and since no hard water is used in any part of the system, there is no scaling problem to complicate maintenance.

The fan is usually driven by V-belt from the engine shaft. Power consumption is usually more than that of the raw water pumps of closed type water cooled systems. Since the fan is operated at constant speed with respect to the engine speed, cooling efficiency will vary as the air temperature. Temperature of the engine jacket water can be controlled by throttling, or by bypassing the radiator.

### Piping and Pumps

On most small engines the soft water pump is usually furnished as part of the engine and is driven by the engine itself. On large units the pump is ordinarily separate and motor driven. Standard centrifugal pumps are best suited for this service.

The total operating head pressure should be carefully calculated, with special attention to the pipe friction losses. Pipe should be sized so that maximum velocity does not exceed 6 ft per sec for 4 in. or larger, or so that the friction drop should not exceed 6 ft per 100 ft of length, for 3 in. pipe or smaller. This practice will result in well balanced systems, with low pressure loss and with uniform velocity of flow in all parts. Careful attention should be given to design of the pipe installation, eliminating every unnecessary turn, fitting or valve.

## The Cover—Deep Well Pumps at Lake Charles

• This month's cover shows mechanics overhauling one of the deep well pumps at the modern refinery operated by Cities Service at Lake Charles, La. Water from the wells is treated for boiler make-up and use in special process operations.

Some idea of the size and complexity of the innumerable steps in petroleum refining at Lake Charles is obtained from these figures:

Over 150,000 bbl of crude oil is refined every 24 hr.
Storage capacity in 140 tanks at the plant is 5,000,000 bbl.
Processes require 4,500 recording and indicating instruments, as well as 25 control boards.
Pipelines total 2,500,000 lineal ft; tubes, 6,000,000 lineal ft.
Nearly 800 pumps keep the refinery's flows in motion.
Over 1,000,000 gal of water are pumped through the plant's cooling systems every 4 min.
Each day 100,000,000 cu ft of gas is fired under boilers and furnaces.
Electrical power generated equals the demand in Omaha.

INDUSTRY AND POWER acknowledges cooperation of Cities Service Company in making the four-color illustration available.

# NOT REMODELLING. . . . .BUT REPLACEMENT AT FALSTAFF

**After purchasing property from an independent brewery, the Falstaff Brewing Corp. installed a completely automatic coal and ash handling system, removed one wall in the powerhouse and extended the building to house a 48,000 lb per hr steam generating unit. Combustion controls were added to hold minimum furnace smoke emission**

**CHARLES H. BERGMANN,**
***Superintendent of Engineering,***
***Falstaff Brewing Corp., St. Louis, Mo.***

***Author, right, discusses the steam operation with Charles Taggert, the chief engineer at Falstaff's No. 5 brewery***

RECENTLY when the Falstaff Brewing Corp. purchased the property of a small independent brewery in St. Louis, Mo., they discovered after a thorough investigation that the powerhouse, ash and coal handling systems were inadequate to handle the proposed steam loads contemplated. Coal and ash were entirely handled manually, causing considerable dust not only in the boiler plant, but in the brewery as well. Coal was dumped at a landing adjacent to the boiler room onto a horizontal conveyer, carried through an open portion of the building wall and dumped on the firing aisle floor. From this point it was shovelled onto the boiler grate.

Unloading time for each coal truck occupied approximately 1½ hr, and for this reason delivery rate was exceptionally high. In addition to the poor coal handling facilities, ashes were dumped from the grate at the back end of the furnace onto the concrete floor. This necessitated shoveling into wheelbarrows and disposing them outside of the boiler room. The dust condition resulting from this storage method was prohibitive.

## Equipment Selection

After careful consideration management at the Falstaff Brewing Corp. decided upon a completely automatic system of coal and ash handling. A further analysis indicated that with future expansion, it would be necessary to install a boiler of greater capacity. With these facts well in mind, the new power plant was designed for the utmost efficiency and ease of operation and maintenance.

## Special Boiler Drum

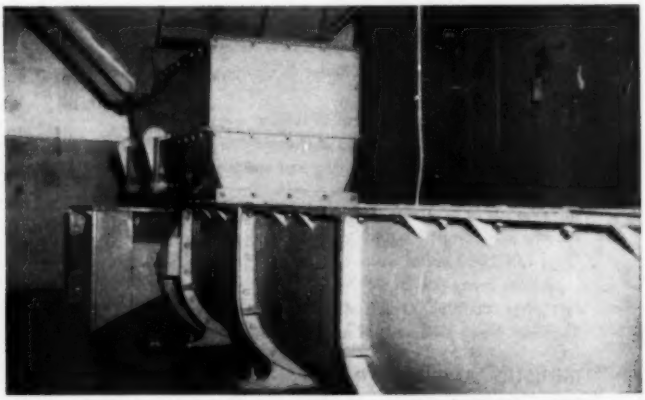
In installing this system one wall of the original boiler plant was knocked out and the room extended to house a 48,000 lb per hr boiler that operates at 150 psi saturated. This unit is equipped with a special drum designed for brewery loads. It is fired with a stoker using Illinois strip mined coal that passes through a 3/4 in. screen.

The new boiler is base loaded and operates continuously. However, the old units are tied into the system, and when necessary they are floated to meet steam demands. At present the new boiler is base loaded at approximately 40,000 lb steam per hr.

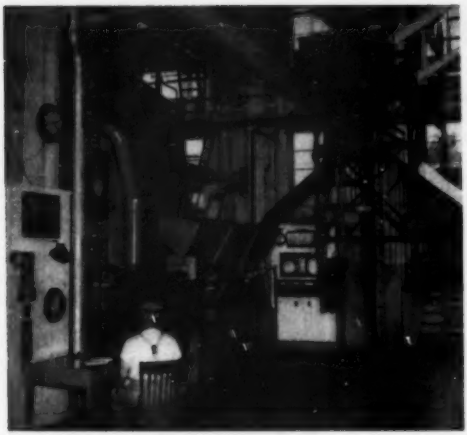
## Coal and Ash Handling

Coal is now dumped into an outside ground level hopper and conveyed to a vertical elevator by a pug mill. It is lifted overhead to a 100-ton capacity storage bin and dropped into a weigh larry. Coal flows evenly into the stoker hopper under control of the operator. As the coal unloading time has been cut to a matter of minutes, the coal trucking company has reduced the hauling charge, which lowered the overall coal cost considerably.

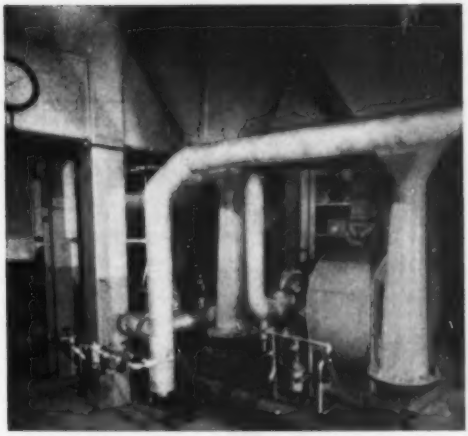
Ash drops off the stoker grate into hoppers at the rear of the furnace. It is conveyed to an outside storage silo



***Coal discharged into outdoor, ground level hopper is delivered to this pug mill, foreground, by a reciprocating plate feeder, background, at a 30 ton per hr rate***



*Operators at this installation take pride in keeping their powerhouse spic and span. Weigh larry has right and left spouts in order to feed either the new or original boilers*



*FD fan is driven with a steam turbine, and the air volume is controlled automatically through outlet dampers. Coal siftings, dropped at grate front are returned and burned*

by means of a pneumatic jet system when necessary. The two original boilers are tied into the same ash handling system, and the laborious means of removing ash has been eliminated. Removing ash from the silo is a simple matter as it is dampened in a dustless discharge mechanism. The coal company that supplies the necessary fuel for the boilers also removes the ashes.

### Minimum of Fly Ash

Fly ash is no problem in this modern plant as overfire jet air is supplied to the firebox. Soot blowers have been installed in the flues, and soot is blown once during a 24-hr period. Fly ash in turn is reinjected into the firebox where it fuses with the ash and is removed in the pneumatic jet system.

Boiler feedwater makeup is relatively high as only 40 per cent of the condensate is returned to the boiler. This makeup is supplied from the city water mains and is treated in a zeolite softener and reduced to zero. Hot phosphate is pumped directly to the boiler at a rate of 20 to 40 ppm.

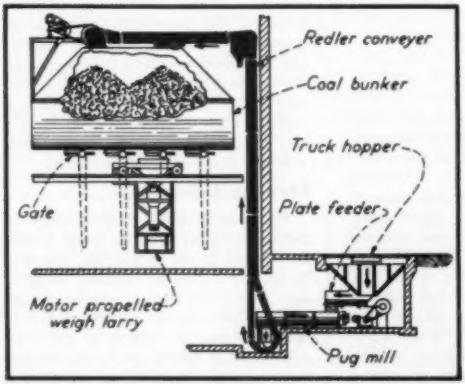
Blowdown is continuous, and it flows into the idle boilers to maintain a concentration and to prevent deterioration. Blowdown enters at the bottom of the boiler, rising to the top and then discharged to the sewer.

Makeup water is heated to 220 F as it passes through the deaerator. Steam from numerous steam turbine operated units is discharged into the deaerator at 3 psi. Air and oxygen are vented.

### Automatic Fuel Control

Combustion is controlled by a fuel-flow air-flow ratio through a master steam pressure controller. On a demand for steam, the air volume is increased followed by an increase in fuel rate. On a reduction in steam demand, the fuel rate is decreased followed by a reduction in air volume. Complete combustion is assured, and air pollution is at the minimum.

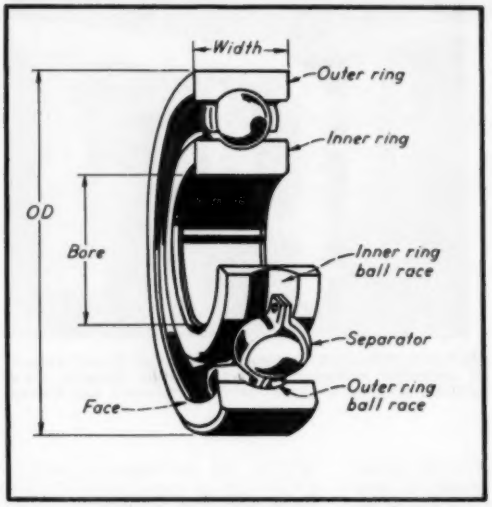
Fuel is modulated by means of a variable speed drive that regulates the speed of the stoker grate. The forced draft fan air volume is controlled with a set of outlet dampers in conjunction with the automatic controls.



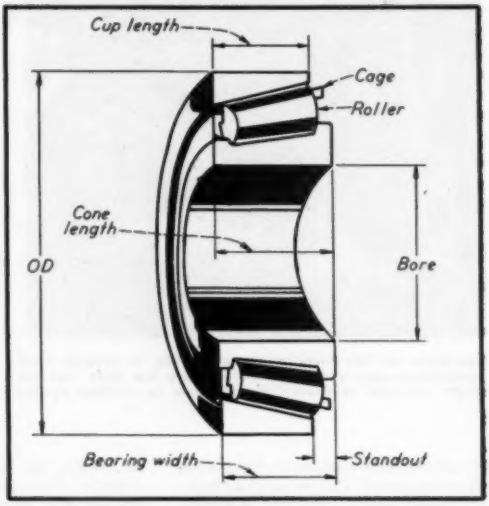

*This reciprocating plate feeder, pug mill and conveyer system can now unload a truck of coal in the matter of minutes*

**PRINCIPAL BOILER HOUSE EQUIPMENT AT FALSTAFF NO. 5 PLANT**

| | |
|---|---|
| Boiler | The Babcock & Wilcox Co. |
| Stoker | The Babcock & Wilcox Co. |
| Overfire jet system | The Babcock & Wilcox Co. |
| Combustion controls | The Hays Corp. |
| Forced draft fan | Westinghouse Electric Corp. |
| Forced draft fan turbine | Elliott Co. |
| Ash conveyer | United Conveyer Corp. |
| Coal handling | Stephens-Adamson Mfg. Co. |
| Soot blowers | Diamond Power Specialty Corp. |
| Water treatment | Elgin Softener Corp. |
| Smoke indicator | Bailey Meter Co. |
| Stoker drive | Reeves Pulley Co. |
| Stoker drive motor | The Louis Allis Co. |
| Feedwater pump | Dean Brothers Pumps, Inc. |
| Feedwater pump motor | The Louis Allis Co. |
| Feedwater pump turbine | Elliott Co. |
| Deaerator | Elliott Co. |
| Piping contractor | Corrigan Co. |




**Ball bearings carry their load on minute spots on opposite sides of the ball that should be clean and well lubricated**




**Load on roller bearing is a straight line, located on top and bottom of the roll and separated by a thin film of oil**

# PROPER MAINTENANCE PROCEDURE MEANS LONGER BEARING SERVICE

**Here are practical and helpful hints on the basic rules for the care and maintenance of anti-friction ball and roller bearings that if followed will increase bearing life and assure uninterrupted service**

**PAUL C. ZIEMKE, *Consultant***

WHEN anti-friction bearings are properly designed, ground and hardened, installed with the best recognized techniques and periodically lubricated with the correct type and quantity of grease they may well outlast the machine. Abuse, rather than use, too often shortens the useful life.

All anti-friction bearings, whether of ball or roller construction, are designed into all types of equipment, primarily to perform one or all of the following functions: (A) improve starting torque by greatly reducing friction, (B) accelerate shaft speeds and accuracies, and (C) concentrates wear on an easily removable part rather than the expensive shaft and housing.

Manufacturers as well as lubrication researchers are constantly improving lubricants needed in modern industry. Every bearing presents a special lubrication problem. Its use, speed and feed in the equipment plays a vital part in lubrication frequency. The quantity of grease that should be added depends, not only on the bearing size, but also on the housing design. The main purpose of grease injection is to improve the seal and replace old discolored lubricant along with entrained matter.

Grease in and around the bearing housing should be replaced. Bearings need not be removed to be cleaned. Generally, except at low speeds, the voids in bearings and about one-quarter of the free space in the housing should be filled with grease. Over-lubrication will cause heating and subsequent early bearing troubles. Before old machinery is placed into service all the bearings should be checked. Lubricant has a tendency to harden into a waxlike mass when equipment is idle, and even high pressure grease guns will not force in fresh lubricant.

## Examine Assembly

Haste may certainly spell waste in bearing removal. The assembly should be studied to determine the best way to remove a bearing without its damage. The inner race is usually put on with a tight fit, the stationary race is never a tight fit. When a piece of equipment is taken apart the bearing stays with the member to which it is tightly fitted. Three methods of bearing removal are: (A) arbor press us-

ing blocks of equal size and well squared to insure even contact, (B) bearing puller when the shaft must remain in the machine. The puller fits behind the bearing or bearing ring. Properly adjusted it cannot slip off the inner ring to damage parts and (C) soft metal drift pins slightly smaller in diameter than the bearing with the inner ring supported. This method unless done with caution is the means of early bearing destruction. To remove the bearing, press or pull only on the ring and then only straight or square to prevent cocking. This can score the shaft or housing, resulting in bearing damage. Above all never press against the separators or shields.

### Arbor Press Procedure

When employing an arbor press, some means should be provided to prevent the shaft from falling to the floor. If shaft or bearing is large and the end cannot be readily squared up with the press ram, two steel blocks can be turned up to make a self-aligning fixture between the ram and shaft. The shaft end should be protected with a pad of copper, lead or other soft metal. The puller must be used with caution, especially for shaft ends containing key-ways, threads or shoulders.

Since the installation is the reverse of removal the same tools are employed. Assuming that the seat is of the correct diameter and without serious taper, the bearing should go all the way to shoulder smoothly with uniform pressure. The right start is necessary. Continued applied force, when not started squarely, is likely to scrape or gouge the bearing seat. If ordinary pressures do not move the bearing it should be removed and inspected for burrs or a tapered seat.

On large bearings the inner rings are usually shrunk on the shafts. This is a simple operation, which consists of heating the bearing or inner ring in clean oil or in a temperature controlled oven at 200 to 250 F. The ring expands so that it slips over the bearing seat shaft. Overheating the bearing will cause loss of hardness. If this method fails the shaft should be shrunk by applying dry ice as the ring is expanded.

### Cleaning Technic

Cleaning operations are an important function that can be done only with proper equipment. Certainly something more is needed than a bucket and a can of gasoline. In fact, gasoline is outlawed by the competent fire-chief and safety engineer. The wire basket suspended in a pan filled with a safe solvent is the mark of the professional. The bearing should soak in the pan for several hours—if an agitator is not used—to dissolve old grease and dirt. Where hardening or "waxing" has occurred the cleaning operation can be hastened by judicious use of a wire brush. Compressed air, at conservative pressures, will greatly facilitate removing the lubricants from between the balls and race, and it will speed the drying operation.

Bearings with side shields or seals need only be washed, inspected and handled in the same manner as ordinary bearings. Bearings with removal seals should be washed and inspected after removal of seals.

However, bearings with seals or shields on both sides should not be washed. These should be wiped off well to keep dirt from working inside. If the inspection reveals them to stick or turn roughly they should be serviced in special equipment rarely found in the average shop.

### Demagnetization

After a thorough cleaning in a solvent, drying by air and a clean, soft cloth is essential. Any traces of lubricant that remains should be removed by a second dipping in clean solvent. When compressed air is used the balls should not be spun. Many times particles of grit remain that will definitely scour the bearing. This is particularly true if the bearing is part of direct current machinery where magnetization is quite often predominant. The foreign particle, if of ferrous nature, will cling to the bearing interior in spite of air jet and spinning can be most damaging. Demagnetization with alternating current fed coils will remove the troublesome condition for the duration of the cleaning and checking operation.

Once the bearings are clean the mechanic must decide as to the extent of wear he will permit before replacement. Wear tolerances for some equipment are very critical, and the least perceptible wear means discarding, while on other machines the bearing may well outlive a second overhaul job. Manufacturers recommendations must be followed for allowable wear tolerances where possible, and the log book will indicate the length of time a certain set of bearings has been in service.

**DON'T CLIP—DON'T TEAR**
**WRITE FOR TEAR SHEETS!**

***Rather than spoil this issue for other readers in your plant, let us supply you with copies or tear sheets of any of the articles for your files. Just drop a line to the editors, preferably on company letterhead, for articles desired.***

### Bearing Protection

Cleaned bearings must be protected while repairs or overhaul are underway on the rest of the machinery. Even the salt of perspiration from mechanics hands may start rust. This can be avoided by coating cleaned bearings with light grease or oil and sealing them in cellophane envelopes until time for assembly.

Cleanliness is probably the key word in anti-friction bearing terminology since it is certainly the watchword throughout the manufacturing processes. All parts, at all times, prior to and after assembly are handled with the greatest care. Dirt, that worked into the bearing from the surrounding air injected with grease through faulty storage and other types of bad housekeeping, is definitely responsible for most failures. Maintenance boxes in many mines and plants contain grease in discarded powder kegs or dynamite boxes, the tops open to receive any and all types of debris. Pressure guns are sometimes carelessly stored in grime and grit not unlike an old track wrench that could not be hurt through rough handling.

### Grease and Abrasives

Maintenance men all too often fail to realize that a mixture of grease and an abrasive form a crude lapping compound. This substance grinds the balls and raceways under high pressures until the fit and accuracy of the bearing is destroyed. Other dirt can impede ball rotation causing flat spots and raceway grooves. This results in heat and lubricant breakdown. Under extreme conditions larger dirt particles can lock a ball to cause raceway breakage and a machine shutdown.

On light, precision machinery stuck balls or those with flat facets may cause chatter marks to form on close tolerance machine work. Many commutator sparking conditions, especially on the smaller machines, can be traced directly to slightly worn ball bearings that permit minute vibrations.

## Materials for engineered plant services

***Types and applications of materials that help to solve problems involving corrosion, abrasion, heat and pressure***

# STANDARDS STUDIED FOR THE CHEMICAL INDUSTRY

**First standard — on stainless steel pipe materials — will be adopted soon and is forerunner of seven other standards now under investigation by ASA subcommittees**

***Variety in materials has led to confusion and high costs in fabrication of piping and vessels for chemical usage***

VARIETY OF MATERIALS and design details have quite naturally kept pace with the tremendous increase of the chemical industry with its competitive nature and the multiplicity of its products. Now, thanks to the Chemical Industry Correlating Committee (CICC), the American Standard for stainless steel pipe (ASAB 3619, Schedule 5S) is being processed by the American Standards Association. Seven other classifications, listed in the table below, are under investigation.

The Correlating Committee of the ASA had its start late in 1949 when a small group of representatives from chemical companies and pressure tubing manufacturers met in New York to explore the possibility of establishing a standard for light weight stainless steel pipe. In spite of a large demand for the tubing, no two chemical companies were in agreement on purchase specifications and tubing manufacturers varied widely in their analyses.

Agreement on the standard was quickly reached but, because the group was informal, the findings could not be sponsored or published as an American Standard. A committee with the formal backing of the industry was required and was provided by the Manufacturing Chemists' Association. Thus, the Correlating Committee came into being May 5, 1950.

Four subcommittees already functioning are: (1) stainless steel pipe and fittings; (2) stainless steel analyses; (3) valves and fittings for hazardous service; and (4) unfired pressure vessels. The first committee has produced the standard on stainless steel pipe. Next is a study of thin walled pipe fabricated from other corrosion resistant materials.

The committee believes that the allowable ranges of chromium and nickel in standard stainless grades are too broad. This has led to the practice of each company developing its own specifications by modifying standard grades. Complicated deliveries and inability of the steel companies to warehouse the wide range of inventories have resulted. The subcommittee will try to correlate the requirements by composition for the various companies. Additions to ASTM standards will be recommended and ultimately it is hoped that appropriate American Standards can also be used.

Products of different manufacturers vary in design, thicknesses, flange facings and drilling templates for valves of the so-called ammonia type used to handle liquids and gases under pressure. Developed for refrigeration service, this type of valve is today handling gases such as ammonia, sulphur dioxide and chlorine. The aim of one subcommittee is to correlate these factors for an American Standard.

There is some feeling that the standard ASME unfired pressure vessel code is too severe in some respects and not severe enough in others for use in the chemical industry. An investigation is being made and will be submitted to the CICC.

With the CICC in operation for little more than a year and one code already well on the way to adoption, the chemical industry has taken its first big step towards standardization.

**CICC PARTICIPATING SOCIETIES**

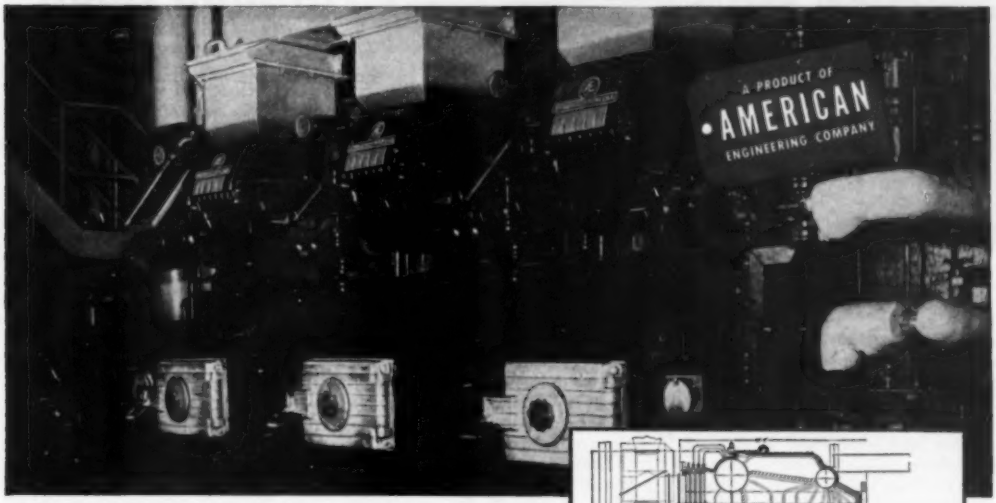
American Institute of Chemical Engineers
American Petroleum Institute
American Society of Mechanical Engineers
American Society for Testing Materials
Compressed Gas Association
Synthetic Organic Chemical Manufacturers Association
Manufacturing Chemists' Association

**SUBJECTS UNDER INVESTIGATION FOR STANDARDS AND CODES**

1. Corrosion resistant flanged valves, flanges and flanged fittings.
2. Chemical industry recommendations for clarification of ASME Boiler Code, Unfired Pressure Vessels Section.
3. Valves and fittings for liquids and gases under pressure, such as sulphur dioxide, chlorine and ammonia.
4. Stainless steel analysis.
5. Storage and handling of anhydrous ammonia and ammonia solutions.
6. Code for pressure piping.
7. Clarification and designation of surface qualities of finished mill products.

# Merck & Co. Inc., get 85% boiler efficiency with

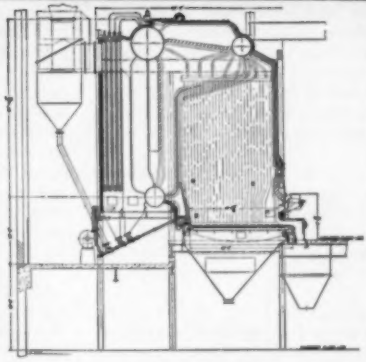
# PERFECT SPREAD STOKER




TEST RUN of a recent Merck installation shows an actual boiler efficiency of 85% operating at average load of 71,500 lbs. per hour. The combination of a modern boiler and a Perfect Spread Stoker permits the use of economical high ash coals and assures big annual savings in fuel costs.

Perfect Spread Stoker burns high and low ash coals with equal facility. Its unique feeder provides positive, continuous coal feed and even distribution. *It never clogs on wet coal.* Its fly ash reinjection and adjustable overfire air system brings maximum fuel economy. And Perfect Spread has a capacity range from 8,000 to 500,000 lbs. of steam per hour. With individual capacities from 50 lbs. to 7500 lbs. of coal per hour, the chain conveyor feeder eliminates puffs of smoke common to slug stoking.

Send for booklet fully describing the Perfect Spread Stoker. And if you are considering boilers in capacities from 300,000 to 500,000 lbs. of steam per hour, call us in to discuss cross-firing.



Edge Moor 3-drum boiler fired by 3-feeder Perfect Spread Stoker with traveling grate. Design engineers, Smith, Hinchman & Grylls, Inc.

**WON'T CLOG ON WET COAL**

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Gentlemen: Kindly send me free copy of Perfect Spread Stoker booklet ( ). I should like to discuss cross-firing ( ).

Name..... Title.....

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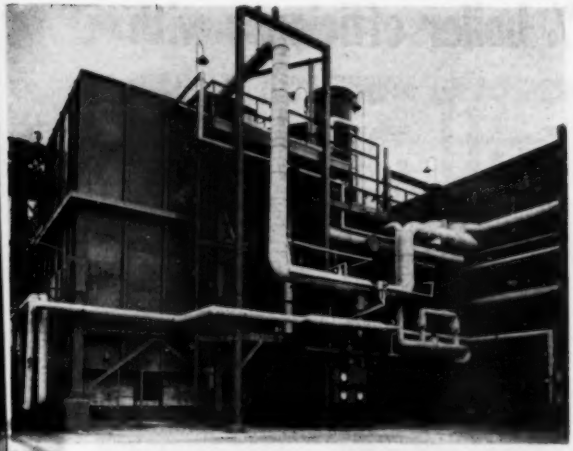


# SUN OIL INSTALLS OUTDOOR BOILER AT MARCUS HOOK

**It was put on the line four months after construction was started. A similar unit will be added in 1952**

***The 155,000 lb per hr boiler at company's principal refinery brings total steam capacity to 1,000,000 lb per hr***

**H. E. MELTON, *Assistant Superintendent***
***Service Div., Marcus Hook Refinery, Sun Oil Company***

ADDITION of new steam generating facilities now gives Sun Oil Company a rated capacity of almost a million pounds of steam an hour to help drive forward a military aviation fuel program at its big Marcus Hook, Pa. refinery. The addition consists of a 155,000 lb per hr B&W boiler with an economizer, forced and induced draft fans with turbine drive and a Thermix stack.

In order to take care of additional steam requirements anticipated in 1952 because of a plant expansion program now under way, another outdoor installation approximating this particular one is expected to be in operation early in 1952.

Although practically all stills and furnaces used in the manufacture of petroleum products at Sun Oil are out-of-doors, this is the first fired boiler installed at Marcus Hook without special housing to shelter it. This construction not only permitted much faster completion but cut the over-all cost in half. The boiler went on the line only four months after the foundation was started. Quick construction was particularly desirable in this case because suddenly accelerated demands from the military created steam requirements unforeseen only a few months earlier.

The picture was complicated, however, when it was discovered that the new boiler could not be completed in time to meet the new demand because of conditions beyond the control of the company. This problem required unusual and not entirely satisfactory temporary measures to solve.

Because of the solution, considerable publicity throughout the country developed before the new boiler was installed and in operation. The unit had been ordered early in 1950 in anticipation of a material increase in steam demand because of the accelerating program in aviation fuel manufacture and the other products needed in connection with national defense that a refinery can supply. Then, because of the delay in delivery of the boiler and arrival of normal winter demands for products, the refinery load was increased sharply. It was at this time that the novel attack was made.

A dozen large steam locomotives were rented from the Pennsylvania Railroad and the Reading Company. These were spotted on three sidings in the refinery and piped up to deliver steam to the refinery steam system. (INDUSTRY AND POWER, April, 1950, page 79.)

The locomotives were equipped to burn coal when they arrived but were quickly converted to gas firing, fuel being supplied from refinery system. They successfully bridged the steam supply gap through the winter until the new steam generating facilities had been erected, tested and turned over to the operators.

With the new boiler in service, 13 fired boilers at Marcus Hook have a rated capacity of 995,000 lb of steam per hour. All steam is generated at 450 psig. Eight of the boilers deliver steam with 120 F superheat. The other five, including the new unit, do not have superheaters.

Condensate return averages about 25 per cent. Make-up is obtained from the adjacent Delaware River, passing through settling tanks, zeolite softeners and deaerating heaters on the way to the boilers.

The new steam generating unit is equipped with combination gas and oil burners for firing natural gas, refinery gas, Bunker "C" and high ash bottoms.

The boiler stands outside at one end of an existing boiler house containing four boilers installed between 1936 and 1947. Feedwater pumps and fuel oil pumps for all five of these boilers, as well as the controls for the new boiler, are in this house. Previously installed auxiliaries such as feedwater pumps, fuel pumps and compressors were hooked up with the new unit; consequently, very little that was new was added in that category.

In order to make room for the new unit, an old boiler house and five long drum box-header type boilers installed between 1916 and 1922 were dismantled. These boilers were rated at 2,000 lb per hr each when operated at 180 psig.

Data on the new boiler are given in the accompanying table.

**DATA ON NEW OUTDOOR BOILER**

| | |
|---|---|
| Builder | The Babcock & Wilcox Co. |
| Design pressure, psig | 475 |
| Heating surface, sq ft | 12,962 |
| Capacity, lb steam per hr | 155,000 |
| Furnace volume, cu ft | 5,704 |
| Burners | 7 B&W gas and oil |
| Economizer | B&W continuous tube |
| Stack | The Thermix Corp. |
| Efficiency, per cent | 81.3 |

## AXIAL & MIXED FLOW PUMPS

*( Continued from page 76 )*

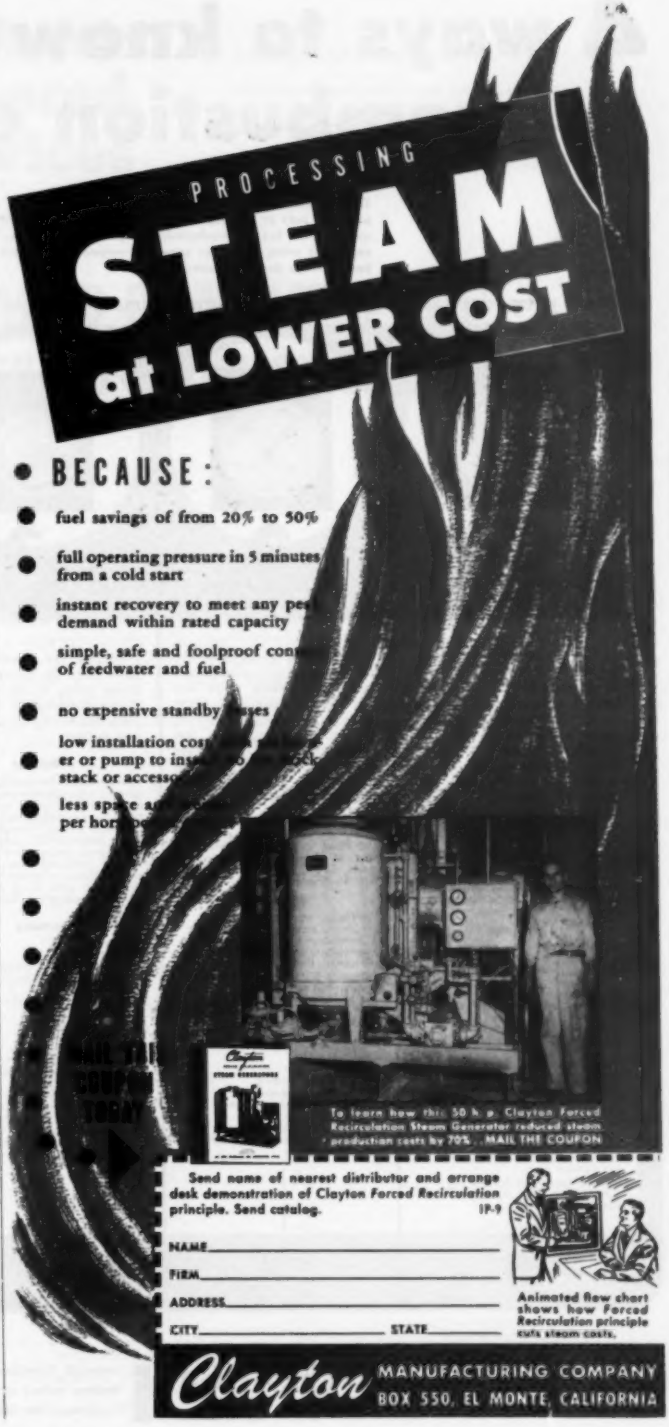
In applying axial-flow pumps to many of the aforementioned services, the use of special materials is frequently required to give the best service. Consideration should be given not only to the material handled, but also to the further complicating factor of cavitation, erosion and corrosion due to the axial-flow pump characteristics.

For many conditions, gray cast iron of the ASTM class 30 or 40 serves satisfactorily for bowls and impellers, and mild steel plate for the column and elbow parts. In more severe chemical service, zincless bronze may be required, such as SAE 63 and SAE 68B aluminum bronze, which assures better protection against mild cavitation. When severe chemical action is anticipated, and cavitation conditions are also present, a special cast alloy containing 24 per cent chromium has been shown to give good service in the field. For such combined extremes, superficial coatings like paints, plastics, rubber and vitreous enamel have been found unacceptable, but each has advantages for limited applications. These coatings have been found to be quite successful in certain water-handling applications, but an investigation is suggested for application not actually involved in severe chemical action.

Buyers and users of engineered pump equipment particularly demand more for their investment and maintenance dollar. With this in mind, leading pump manufacturers have made continuous efforts toward design and application improvements in all their products. Problems concerning sumps and cavitation, for example, are very extensive. The resources of several of the nation's outstanding universities are being utilized in collaboration with manufacturers to help in the practical solution of many of the field problems.

Vane and flow passage shapes have been analysed, tested and revised to gain more efficient and enduring performance in the field. To many unusual applications, studies and tests are now in process to determine many of the transient characteristics as the operation passes from the pump phase to the turbine phase. Such a condition exists when the pump stops and the flow is reversed. The pump then operates as a turbine, and run-away speeds must be considered.

Some of this research has resulted in broader application range by variations of impeller vane pitch, camber, diameter and general profile together with related changes and stationary vanes at the entrance and exit. Records of field problems are carefully assembled.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Animated flow chart shows how Forced Recirculation principle cuts steam costs.
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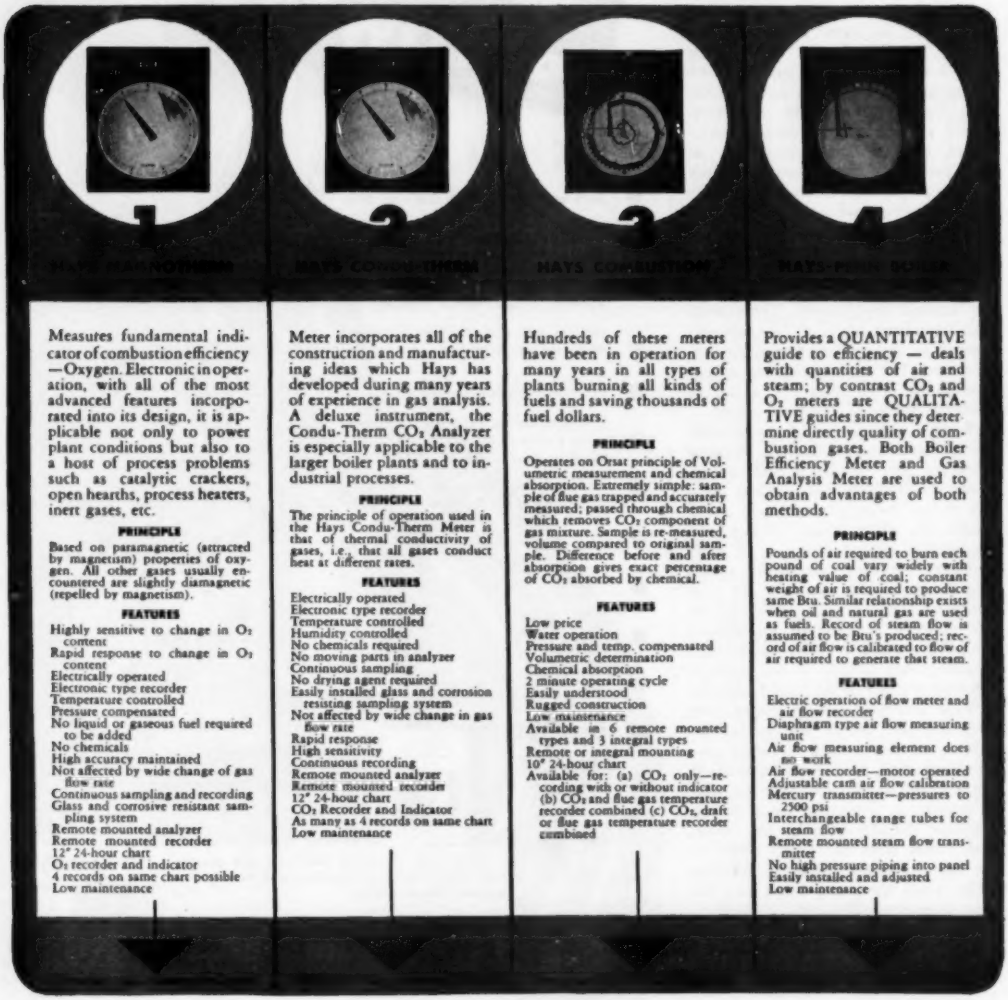
# 4 ways to know your combustion efficiency

**The ever-increasing pressure for fuel economy makes some type of "combustion guide" instrument an essential part of any modern fuel burning operation. Hays offers the most complete line of such instruments in the industry—adaptable to your cost and engineering requirements. Your particular needs with regard to price, accuracy, speed of response, etc., will determine your choice—however, whatever your needs, Hays has the instrument.**

**Select your combustion guides *from the most complete line in the industry***




Measures fundamental indicator of combustion efficiency —Oxygen. Electronic in operation, with all of the most advanced features incorporated into its design, it is applicable not only to power plant conditions but also to a host of process problems such as catalytic crackers, open hearths, process heaters, inert gases, etc.

**PRINCIPLE**

Based on paramagnetic (attracted by magnetism) properties of oxygen. All other gases usually encountered are slightly diamagnetic (repelled by magnetism).

**FEATURES**

Highly sensitive to change in $O_2$ content
Rapid response to change in $O_2$ content
Electrically operated
Electronic type recorder
Temperature controlled
Pressure compensated
No liquid or gaseous fuel required to be added
No chemicals
High accuracy maintained
Not affected by wide change of gas flow rate
Continuous sampling and recording
Glass and corrosive resistant sampling system
Remote mounted analyzer
Remote mounted recorder
12" 24-hour chart
$O_2$ recorder and indicator
4 records on same chart possible
Low maintenance

Meter incorporates all of the construction and manufacturing ideas which Hays has developed during many years of experience in gas analysis. A deluxe instrument, the Condu-Therm $CO_2$ Analyzer is especially applicable to the larger boiler plants and to industrial processes.

**PRINCIPLE**

The principle of operation used in the Hays Condu-Therm Meter is that of thermal conductivity of gases, i.e., that all gases conduct heat at different rates.

**FEATURES**

Electrically operated
Electronic type recorder
Temperature controlled
Humidity controlled
No chemicals required
No moving parts in analyzer
Continuous sampling
No drying agent required
Easily installed glass and corrosion resisting sampling system
Not affected by wide change in gas flow rate
Rapid response
High sensitivity
Continuous recording
Remote mounted analyzer
Remote mounted recorder
12" 24-hour chart
$CO_2$ Recorder and Indicator
As many as 4 records on same chart
Low maintenance

Hundreds of these meters have been in operation for many years in all types of plants burning all kinds of fuels and saving thousands of fuel dollars.

**PRINCIPLE**

Operates on Orsat principle of Volumetric measurement and chemical absorption. Extremely simple: sample of flue gas trapped and accurately measured; passed through chemical which removes $CO_2$ component of gas mixture. Sample is re-measured, volume compared to original sample. Difference before and after absorption gives exact percentage of $CO_2$ absorbed by chemical.

**FEATURES**

Low price
Water operation
Pressure and temp. compensated
Volumetric determination
Chemical absorption
2 minute operating cycle
Easily understood
Rugged construction
Low maintenance
Available in 6 remote mounted types and 3 integral types
Remote or integral mounting
10" 24-hour chart
Available for: (a) $CO_2$ only—recording with or without indicator (b) $CO_2$ and flue gas temperature recorder combined (c) $CO_2$, draft or flue gas temperature recorder combined

Provides a QUANTITATIVE guide to efficiency — deals with quantities of air and steam; by contrast $CO_2$ and $O_2$ meters are QUALITATIVE guides since they determine directly quality of combustion gases. Both Boiler Efficiency Meter and Gas Analysis Meter are used to obtain advantages of both methods.

**PRINCIPLE**

Pounds of air required to burn each pound of coal vary widely with heating value of coal; constant weight of air is required to produce same Btu. Similar relationship exists when oil and natural gas are used as fuels. Record of steam flow is assumed to be Btu's produced; record of air flow is calibrated to flow of air required to generate that steam.

**FEATURES**

Electric operation of flow meter and air flow recorder
Diaphragm type air flow measuring unit
Air flow measuring element does no work
Air flow recorder—motor operated
Adjustable cam air flow calibration
Mercury transmitter—pressures to 2500 psi
Interchangeable range tubes for steam flow
Remote mounted steam flow transmitter
No high pressure piping into panel
Easily installed and adjusted
Low maintenance

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Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages
Combustion Test Sets • $CO_2$ Recorders • Electronic Oxygen Recorders

# Handbook for engineered plant services

***Methods, data and ideas that make excellent references in solving engineering problems frequently encountered in plant operations***

# RESISTANCE OF VALVES AND FITTINGS TO FLOW OF FLUIDS

WHEN THE FLOW of a fluid in a pipe line is altered by some obstruction such as a valve or fitting, the velocity is changed, turbulence is magnified, and a drop in pressure results. This pressure drop may be insignificant in long lines where it is very small in comparison to the total drop, but when the line is short, the pressure drop through valves and fittings becomes a major item in the total pressure drop value.

The most widely used data on the subject of the resistance of valves and fittings to the flow of water and steam is the information given in Dean Foster's paper on "Effect of Fittings on Flow of Fluids Through Pipe Lines" (published in Vol. 42, 1920, of the *Transactions of the American Society of Mechanical Engineers*). Later tests conducted by others have indicated that the values given by Foster are low for globe valves, angle valves, etc., and that data are needed to establish the correct information to use.

It has been the tendency, and probably is the most practical way, to present the friction values in terms of an equivalent length of the same size of pipe; i.e., the pressure drop caused by a 2 in. elbow is equivalent to approximately the pressure drop caused by 5 or 6 ft of 2 in. pipe under the same conditions of flow.

In this way, water and steam can be treated comparatively and a relation can be established between the relative friction values of water and steam. Foster has stated that the equivalent length of pipe for steam flow is about 0.8 of that established for the flow of water.

Realizing the need for definite data covering this subject, Crane Co. has conducted pressure drop tests on valves and fittings on both water and steam. These tests were made on 2 in. and 6 in. sizes and conducted under conditions which were thoroughly investigated previous to the making of these tests.

### Resistance In Pipe Length

From data given in the tests and also from information gathered from authentic sources, the chart shown on the next page has been prepared. The chart gives the equivalent length of pipe to produce the same pressure drop as a valve or fitting. This additional pipe length should be added to the length of the line in order to determine the total pressure drop.

Procedure in using the chart on the following page is exemplified by the heavy dashed line, and for which a 6 in. standard elbow has been selected. Here, reference is first made to the diagram in the left-hand column and following the leader line to the left-hand verticle rule. From the dot so located, the heavy dashed line was drawn to 6 in. on the right-hand scale. The dashed line crosses the center scale at 16, indicating that resistance to flow in the 6 in. elbow is equivalent to approximately 16 ft of standard diameter pipe.

It has been shown by previous investigators that the drop in pressure through valves, fittings, etc., is some constant multiplied by the velocity head

$$\frac{V^2}{2g}$$

Therefore: $H_1 = k\frac{V^2}{2g}$

Where

$H_1$ = Loss of head, ft

$k$ = Coefficient (Values given in the accompanying table.)

$V$ = Velocity of water, fps

$2g = 64.4$

*Courtesy of Crane Co.*

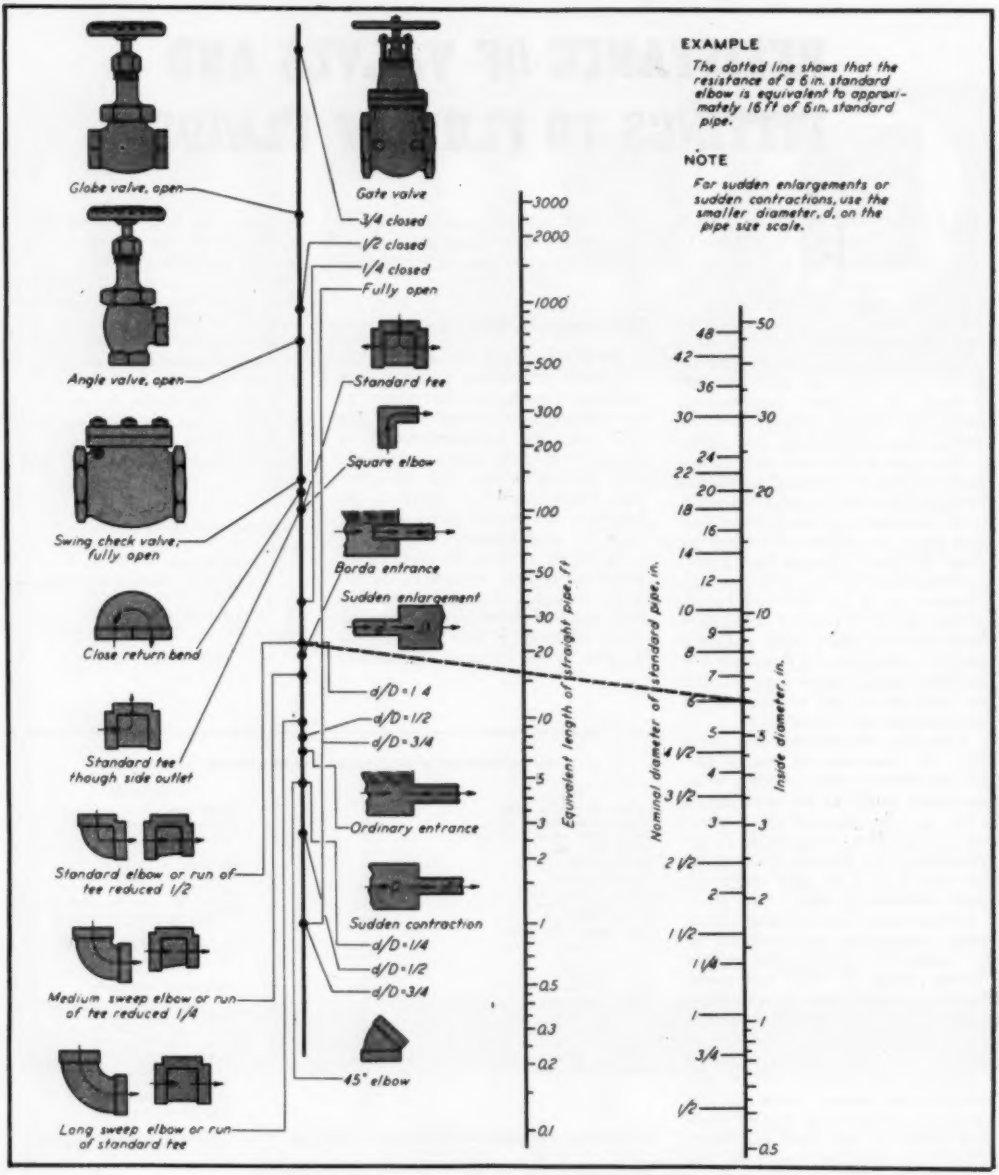
**REPRESENTATIVE k VALUES FOR VARIOUS VALVES AND FITTINGS**

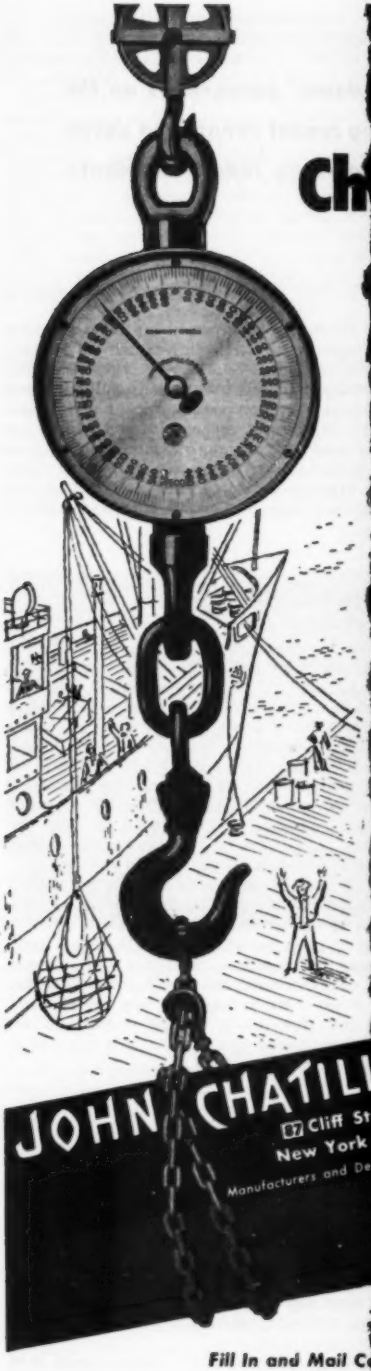
| Type | k | Authority |
|---|---|---|
| Globe valve (fully open) | 10.0 | Crane tests |
| Angle valve (fully open) | 5.0 | Crane tests |
| Swing check valve (fully open) | 2.5 | Crane tests |
| Close return bend | 2.2 | |
| Standard tee | 1.8 | Giesecke & Badgett |
| Standard elbow | 0.9 | Giesecke & Badgett |
| Medium sweep elbow | 0.75 | Crane tests |
| Long sweep elbow | 0.60 | Bulletin No. 2712—University of Texas |
| 45 deg elbow | 0.42 | Bulletin No. 2712—University of Texas |
| Gate valve (fully open) | 0.19 | |
| ¼ closed | 1.15 | University of Wisconsin tests* and Crane tests |
| ½ closed | 5.6 | |
| ¾ closed | 24.0 | |
| Borda entrance | 0.83 | "Hydraulics" Daugherty |
| Sudden enlargement: | | |
| $d_2/d_1 = \frac{1}{4}$ | 0.92 | "Hydraulics" Daugherty |
| $d_2/d_1 = \frac{1}{2}$ | 0.56 | "Hydraulics" Daugherty |
| $d_2/d_1 = \frac{3}{4}$ | 0.19 | "Hydraulics" Daugherty |
| Ordinary entrance | 0.5 | "Hydraulics" Daugherty |
| Sudden contraction: | | |
| $d_2/d_1 = \frac{1}{4}$ | 0.42 | "Hydraulics" Daugherty |
| $d_2/d_1 = \frac{1}{2}$ | 0.33 | "Hydraulics" Daugherty |
| $d_2/d_1 = \frac{3}{4}$ | 0.19 | "Hydraulics" Daugherty |

*University of Wisconsin Experimental Station Bulletin, vol. 9, No. 1, 1922.

( Continued from page 111 )

# RESISTANCE OF VALVES AND FITTINGS TO FLOW OF FLUIDS


EXAMPLE
The dotted line shows that the resistance of a 6 in. standard elbow is equivalent to approximately 16 ft of 6 in. standard pipe.
NOTE
For sudden enlargements or sudden contractions, use the smaller diameter, d, on the pipe size scale.
Globe valve, open
Angle valve, open
Swing check valve, fully open
Close return bend
Standard tee though side outlet
Standard elbow or run of tee reduced 1/2
Medium sweep elbow or run of tee reduced 1/4
Long sweep elbow or run of standard tee
Gate valve
3/4 closed
1/2 closed
1/4 closed
Fully open
Standard tee
Square elbow
Borda entrance
Sudden enlargement
d/D = 1/4
d/D = 1/2
d/D = 3/4
Ordinary entrance
Sudden contraction
d/D = 1/4
d/D = 1/2
d/D = 3/4
45° elbow
Equivalent length of straight pipe, ft
Nominal diameter of standard pipe, in.
Inside diameter, in.



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These remarkable spring-type, direct reading and large capacity Chatillon Crane Scales are engineered to withstand rugged service that would ruin other types of weighing apparatus.

Built for 1,000 to 10,000 capacities, each scale is equipped with two special alloy steel springs, precision calibrated and designed for maximum safety. Virtually indestructible, every Chatillon Crane Scale has a recoil mechanism which protects the rack and pinion against sudden shock; a recessed dial to protect pointer; large easy to read aluminum dial with black graduations and figures, and cases made of malleable iron, with top and bottom rings drop forged. Lightweight and less cumbersome, a 5,000 lb. Chatillon Crane Scale weighs only 93 lbs.

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| 13-20000 | 2000x5 | 78 |
| 15-50000 | 5000x10 | 93 |
| 16-100000 | 10000x25 | 240 |

Weights given above are shipping weights. To order Crane Scale with Hook, add letter H to Catalog number, i.e.: 10-10000H, 13-20000H, etc.

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# Spot news

***Short, "boiled-down" paragraphs on the most interesting recent events and developments in American industrial plants.***

## Power Distribution Exhibit Goes on National Tour

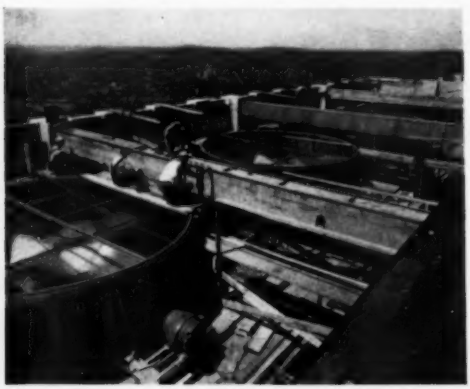
Emphasizing the importance of properly applied electrical equipment for increased production, a travelling industrial power exhibit is being sponsored by Westinghouse Electric Corp. and its distributors. Called "More Production Ahead," it now is on a tour of industrial centers as a part of a planned power distribution program.

J. L. Wagoner, exhibit lecturer, uses a three-dimensional model factory, as well as models of standardized power distribution equipment, to lay out a modern power distribution system for the audience. Playing the role of the model factory's plant engineer, Mr. Wagoner analyzes power loads and diversity factors. He finally decides that a 2000-amp service is ample to meet the plant's present and anticipated power requirements.

Mr. Wagoner also reviews the following four essential devices necessary for the protection and operation of motor branch circuits: (1) over-current protection, to protect the motor and its controller against dangerous overloads and short-circuit conditions; (2) the disconnect; (3) the motor starter; and (4) the motor running and over-current protection to protect against running overloads.

## Multi-Million Dollar Air-Conditioning System Provides Man-Made Weather in 41-Story Building

In a two story recess atop Pittsburgh's newest and largest skyscraper is the 97 ft long cooling tower shown in the illustration. The tower is part of the multi-million-dollar heating, ventilating and air conditioning system designed by Dravo Corp. engineers for the 41-story building to be occupied by U. S. Steel Co. and Mellon National Bank & Trust Co.



***Cooling tower 97 ft long installed on top of Pittsburgh's newest skyscraper is part of air conditioning system which has a total refrigeration capacity of 2,500 tons***

An idea of the scope of the project can be gained from a few of the major statistics. Cooling capacity of refrigeration equipment for the air conditioning system is equivalent to the melting effect of more than five million pounds of ice daily. About 50 million pounds of steam will be used annually. Some 16 miles of copper pipe and tubing and 13-½ miles of steel pipe ranging in diameter from ¼ in. to 24 in. are needed to carry steam, condensate, hot water, chilled water, drainage and compressed air. Total capacity of all fans that move air in the building amounts to 528,000 cu ft per min.

## 16-Story High Boiler Generates 650,000 lb of Steam per hr

The largest and highest pressure boiler in northern Ohio went into operation early last month at the Acme Station of the Toledo Edison Co. Designed and built by The Babcock & Wilcox Co., it joins 17 older units at the station and will generate steam to produce 80,000 kw of electricity.

The latest unit is housed in a building originally intended for a boiler to generate 35,000 kw. While it occupies the same 34 by 56 ft floor space, increased capacity is achieved by building the unit as tall as a 16-story building. Increased pressure is possible because of heavier walls for tubes and other parts. The boiler contains 73 miles of tubes which were fabricated by The Babcock & Wilcox Tube Co.

Generating 650,000 lb of steam per hr, the boiler operates at the unusual pressure of 1500 psig, which is a pressure equivalent to that generated by a waterfall 3,600 ft high, or almost 22 times that of Niagara Falls. Steam leaves the boiler proper at 600 F, goes through a superheater in the boiler, and enters the turbine at 1000 F, containing 1490 Btu per lb of steam at the turbine. The new unit is fueled by pulverized coal, down-firing through multitip burners into a divided water-cooled type furnace. It is expected to consume around 33 tons of coal per hr.

## Manpower Pinch Brings Demand For More Automatic Processes

Demand for scientific apparatus and process instruments for basic defense industries is running 250 to 300 per cent above pre-Korean levels, according to Henry F. Dever, president of Brown Instruments Div. of Minneapolis-Honeywell. He reports that the end of this demand is not in sight, and attributes this to recognition of these devices as the fastest method for expanding industrial production without necessarily adding to plant facilities. He stated:

"The engineering challenge facing America today is to break down complicated industrial process operations into simpler tasks where new employees can do the work of

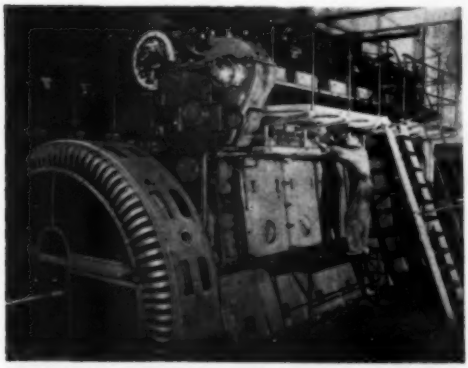
scarce, skilled workers. An economy of guns and butter presents more engineering and manpower problems than we had early in World War II since we do not have the 8,000,000 unemployed to draw from now that we had then."

The manufacture of process instruments, said Dever, is not large either in dollar volume or in requirements for essential materials. However, "the 15 or 20 companies that specialize in these devices provide the catalyst that speeds output in vital industries such as heavy chemicals, metal producing and processing, petroleum, rubber, plastics, pipe lines, textiles and atomic energy. At our level of control apparatus the business does not run more than $60 to $100 million annually, but when we are talking about finished products we are talking about $25 billions or more of goods essential to the war effort."

## Diesel Engines Provide Emergency Power In a Hurry for North Dakota Power Coop

Three 2250 hp Hamilton diesel engines in the Harwood station of the Minnkota Power Cooperative, Inc. in North Dakota were put on the line in 6 min last month when the main feeder into the Harwood area was cut by a crop dusting plane. The engines had to pick up a load of 4,000 kw.

The three engines operate 1 to 4 hr per day for peaking



***Three 2250 hp diesel engines handle peak loads in North Dakota power system which serves rural area in Red River valley. Transmission lines cover 40,000 square miles***

purposes and have an average output of 250,000 kwh per month. Cost of power was 0.94 cent per kwh during a recent month. The figure varies somewhat with fuel cost. The plant is used to supplement steam power capacity of 10,000 kw in the system. Its maximum output for a single month was 1,500,000 kwh when the plant operated 16 hrs a day.

## Ohio's Coal Production Increased 500,000 Tons As New Mine Opens

A new coal mine, just opened near Wellston, Ohio by the Southern Coal Co., will expand the state's annual production more than a half million tons. The company will distribute the coal under the trade name "Broken Aro," with principal market areas comprising Ohio, Michigan and Eastern Indiana.

The Broken Aro processing plant incorporates the latest types of coal cleaning and preparation equipment. Special

When you specify insulation, be sure that it carries this seal! Authorized by the Industrial Mineral Wool Institute, the certification label assures you that the product has passed stringent laboratory tests and meets requirements prescribed by the National Bureau of Standards.

*Specify Baldwin-Hill insulation materials... Your guarantee of certified quality and reliability.*

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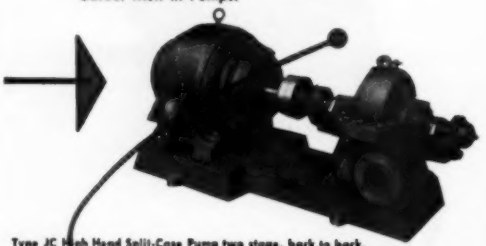
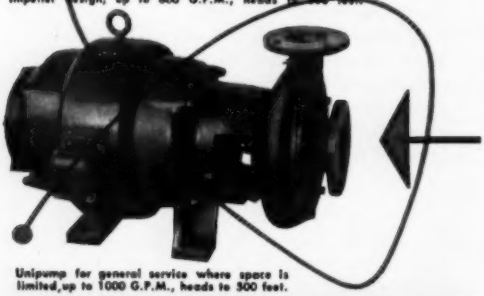


Type JC High Head Split-Case Pump two stage, back to back, impeller design, up to 600 G.P.M., heads to 600 feet.



Unipump for general service where space is limited, up to 1000 G.P.M., heads to 500 feet.

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The WEINMAN Pump Mfg. Co.

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REPRESENTATIVES IN PRINCIPAL CITIES


# Spot news

*( Continued from page 115 )*

emphasis has been given to engineering techniques which will produce a coal of exceptional uniformity. Cleaning equipment includes modern specific gravity washers as well as precision sizing and scientific blending units. As a precaution to assure industrial users of a dependable supply, all-weather roads have been constructed and extensive pumping facilities installed for uninterrupted production.

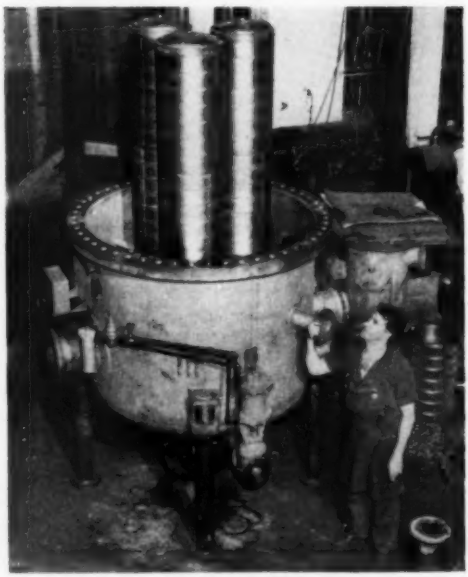
As a producer and shipper, Southern Coal Co., Inc., with headquarters in Chicago, is currently marketing in excess of ten million tons of coal annually from the leading fields in Ohio, Western Kentucky, Indiana and Illinois.

## Standards of Interchangeability for 30 Types and Sizes of Fluorescent Lamps Are Published

After five years of study and investigation, standards of interchangeability for 30 different types and sizes of fluorescent lamps have just been approved and published by the American Standards Association. As a result, it is now possible for consumers to specify a lamp of a given type with the assurance that lamps made by any of the various manufacturers will be mechanically and electrically interchangeable.

These standards fully describe each lamp under the head-

*( Continued on page 164 )*



***LARGEST STRAINER WILL HANDLE 15,000 GPM***

***Rated to handle 15,000 gal of fluid per min, the Flo-Kleen strainer shows without its "bonnet" is largest unit built. Equipped with automatic sludge blow downs, it will operate continuously according to builders, Cuno Engineering Corp.***

## Stoker Firing of Low-Grade Fuels

*( Continued from page 92 )*

carried away by the combustion gases, and as stated above usually set the upper limit to the combustion rate. Cyclone collectors or electrostatic precipitators must be used. Systems have also been designed which return part of the grit to the furnace.

*7. Ash Handling* — The increased percentages of ash associated with inferior fuels place a special strain on the ash-handling equipment unless it has been specially designed for such fuels.

*8. Steam Output* — Theoretically it should be possible to maintain the same output for a given heating surface with any type of fuel by merely adjusting the hourly rate of burning according to the calorific value. In practice, however, there is usually experienced a drop of evaporation for a given surface when using low-grade fuels. This is due to a number of factors:

*(A)* As discussed above, the maximum burning rate (lb per sq ft per hr) is limited by grit emission and is lower than for a graded fuel. This, together with the lower calorific value, may result in a drop of some 50 per cent in the rate of heat release.

*(B)* The high ash content and difficulty of distributing fine fuels evenly over the grate result in an irregular fuel bed. Air will make its way through the thinner patches or holes, increasing the excess air and lowering combustion efficiency. This is accompanied by a marked drop of furnace temperature and radiant heat transfer. The convection surfaces do not absorb all the surplus heat carried over from the radiant zone and the final result is a reduction of boiler efficiency.

*(C)* The loss of heat represented by the fine fuel lost through the air spaces of the stoker, the grit carry over, and combustible in the ash may cause a further reduction in the available heat.

It is evident therefore that for a desired steam output both a larger grate area and additional heating surfaces are required to allow for the combined effects of reduced combustion rate and boiler efficiency. This entails larger capital outlay which, however, may be off-set by the lower cost of the low-grade fuels and the greater flexibility with regard to types of fuel usable. Generally, though, the real difficulty arises when existing plant has to be converted to low-grade fuels and when no spare boiler capacity is available.

high efficiency
AEROTEC
DUST COLLECTORS
Partially erected collector showing inlet, outlet and dust discharge passages.
New Niagara-Mohawk Power Corporation Dunkirk Steam Station, equipped with Aerotec Dust Collectors
assure your plant

**NIAGARA MOHAWK POWER CORPORATION**

***Dunkirk Station . . . and a duplicate Albany Plant***

At the new Dunkirk Steam Station of Niagara Mohawk Power Corporation, two reheat steam generators of 670,000 lb. per hour capacity are pulverized fuel-fired. Dust collection for this station is handled by Aerotec, Design 3 RAS Collectors, and a duplicate system is under construction for the new Albany Steam Plant . . . making a total of eleven Niagara Mohawk boilers to be equipped with Aerotec Dust Collectors.

The collectors for Dunkirk and Albany consist of 84 "Unit Building Block" elements completely assembled at the factory for easy erection in the field. The small diameter tubes, of permanent molded aluminum construction, have proved their extremely high collection efficiency and long life on hundreds of installations. Their light weight cuts steel requirements for supporting structure, and makes possible roof installations with a minimum of reinforcement. The light weight tubes also reduce erection costs.

Aerotec efficiencies meet or exceed the requirements of most dust ordinances today. Evenly spaced tube outlets provide excellent inlet flow conditions for an AEROTEC electrical secondary—should future ordinances require still higher efficiencies.

*Write for the new Design 3 RAS Catalog No. 601.*

*Project and Sales Engineers*

**THE THERMIX CORPORATION**

GREENWICH, CONNECTICUT

*(Offices in 28 Principal Cities)*

*Canadian Affiliates:* T. C. CHOWN, LTD.
1440 St. Catherine St., W., Montreal 25, Quebec • 50 Abell St., Toronto 3, Ontario

**THE AEROTEC CORPORATION**

GREENWICH, CONNECTICUT

Manufacturers of mechanical dust collectors, electrical precipitators, air cleaners, industrial integral dust collectors, gas-oil scrubbers and dust reclaiming equipment.

# News
## of men and companies

### ANNIVERSARIES

**The Louis Allis Co.**—Announced their 50th anniversary in special edition of house organ "Messenger".

**Sylvania Electric Products, Inc.**—Observed the 50th anniversary of its founding in July.

### NEW REPRESENTATIVES

**Metals Disintegrating Company, Inc.**—The Roy A. Ribelin Distributing Co., 570-A M. & M. Building, Houston, Texas, is appointed distributor.

**Cannon Electric Co.**—Gates Co., Salt Lake City, has been appointed factory representative replacing Mt. States Engineering Co.

**Carboloy Dept., General Electric Co.**—Tools and Abrasives, Inc., 1510-12 Oxford St., is now an authorized distributor for the Fort Wayne, Ind. area.

**General Electric Co.**—The new Dayton branch of the Burdett Oxygen Co. will serve as distributors for complete line of G-E welding equipment.

**The Standard Transformer Co.**—Carl A. Froebel Co. recently appointed as representative is located at 4030 Chouteau Ave., St. Louis 10, Mo.

### HONORS

**The American Society of Mechanical Engineers**—Eight members of ASME were elected to the grade of Fellow. The newly-elected Fellows are: H. D. Harkins, supervising engineer, E. I. Du Pont de Nemours & Co., Inc.; F. P. Fairchild, chief engineer, electric engineering dept., Public Service Electric and Gas Company; J. A. Freiday, mechanical engineer, Ebasco Services Incorporated; G. P. Jackson, chief engineer, Combustion Engineering-Superheater, Inc. Also, Dr. G. B. Pegram, v-p, Columbia University; P. V. Miller, manager, small tool and gage div., The Taft-Peirce Mfg. Co.; W. E. Caldwell, staff engineer, mechanical engineering dept., Consolidated Edison Company of New York, Inc.; and C. F. Dixon, supervising engineer, United Engineers and Constructors, Inc.

**The Babcock and Wilcox Co.**—E. G. Bailey was selected to receive the 1952 John Fritz Medal and Certificate "for outstanding engineering achievements in the field of combustion and distinguished service to his fellows in advancing the engineering profession."

J. F. McKee

**Yarnall-Waring Co.**—J. F. McKee, research engineer, has been awarded a Certificate of Merit by The Franklin Institute for his development of a small, lightweight steam trap which is factory adjusted to meet a wide range of conditions and pressures.

**The Babcock & Wilcox Tube Co.**—Geneva College awarded the honorary degree of Doctor of Laws to L. E. Sawyer, president.

### SALES OFFICES

**The Babcock & Wilcox Tube Co.**—The Pacific Coast office, formerly located at 714 Olympic Boulevard in Los Angeles, will now be in the Lawson-Chipman Building at 1111 Wilshire Boulevard.

**• The National Production Authority, U. S. Department of Commerce, announced the membership list of the Power Switchgear and Circuit Breaker Industry Advisory Committee as follows:**

J. S. Morgan, manager
Switchgear Section
Allis-Chalmers Mfg. Co.

W. F. Rauber, manager sales
Switchgear Division
General Electric Co.
Philadelphia Works

G. E. Heberlein, manager
Switchgear Division
I-T-E Circuit Breaker Co.

Edward F. Sixtus, vice president
Pacific Electric Mfg. Corp.

D. O. Eschbach, general sales mgr
Roller Smith Corp.

J. T. Thompson, assistant manager
Switchgear Application
Westinghouse Electric Corp.

W. J. Mann, Jr., president
Wolfe & Mann Mfg. Co.

Martin Zinsmeyer, president
Zinsco Electric Products

### PHILADELPHIA GROUP STUDIES INSULATION PROBLEMS

*One hundred engineers interested in heat insulation have organized "The Thermal Insulation Society". The first president is W. H. Zane, du-Pont Co. engineer and vice-chairman of the ASTM C-16 committee on insulation specifications.*

*Membership is open to men interested in the manufacturing, application, specification, and distribution of insulation. By accumulating information gathered by various groups, the society plans to serve a long recognized need for insulation specifications based on a broad knowledge of engineering, theory and practice. Furthermore, by promoting a better understanding between manufacturer, applicator and final consumer, there will develop better products, better methods of application and more intelligent specifications.*

**Dow Corning Corp.**—Have moved general offices to 600 Fifth Avenue, New York 20, N. Y.

**The Electric Products Co.**—Recently established a Chicago sales and service office headed by A. O. Seehafer.

**The Griscom-Russell Co.**—Moved its general offices from New York City to Massillon, Ohio.

**Heli-Coil Corp.**—New plant at Danbury, Conn., will house all manufacturing and general office activities.

**Independent Pneumatic Tool Co.**—Transferred its Cincinnati branch to 37 26-28 Floral Avenue.

**Kennametal Inc.**—Cincinnati office has been moved to 4873 Reading Road; and in Minneapolis to 1016 Metropolitan Building.

**Prat-Daniel Corp.**—Plant and general offices now located in South Norwalk, Conn.

**Industrol Corp.**—Purchased by Trinity Equipment Corp. and moved to the Trinity office and plant at Roselle Park, N. J.

**Republic Flow Meters Co.**—Seattle, Wash., district office at 1002 Second Ave., with H. Weber as district manager.

**Worthington Pump & Machinery Corp.**—New branch office in Harrisburg, Penn., at 506 Hall Building, 2nd and Locust Streets, will be in charge of A. L. Mays.

**The Powers Regulator Co.**—General offices and factory moved to 3400 Oakton St., Skokie, Ill.

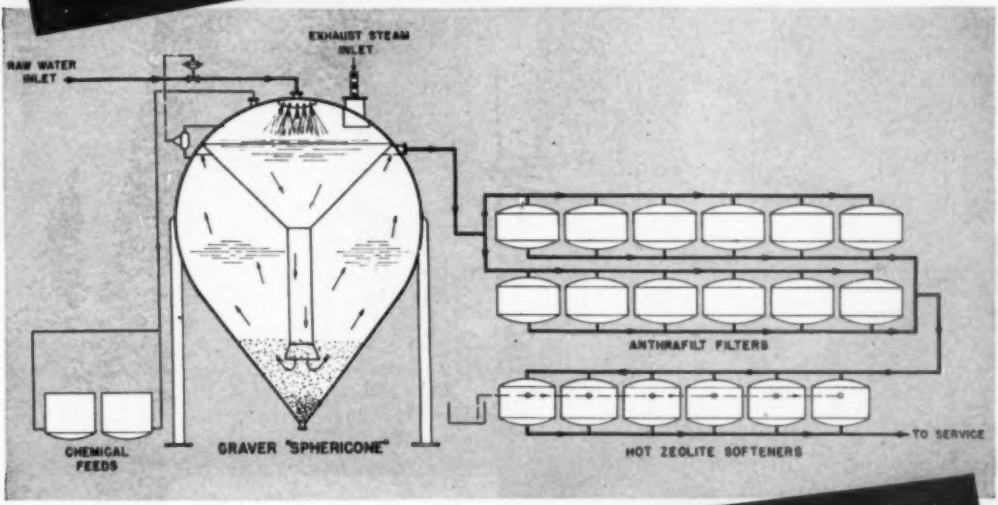
### EXPANSIONS

**Diamond Alkali Co.**—A two-year, multi-million-dollar program of plant expansion at the Painesville (O.) plant was announced.

**Brooks & Perkins, Inc.**—Ground has been broken just outside Detroit for a new magnesium rolling mill.

***( Continued on page 122 )***

# World's Largest HOT PROCESS- Hot Zeolite Plant




When a large eastern refinery wanted the most modern, efficient and economical treating system to handle 200,000 gph of feedwater ... virtually 90 to 100% make-up ... for their 650 psig boilers, their engineers selected a GRAVER Hot Process-Hot Zeolite plant employing GRAVEX styrene zeolite.

## Advantages of this type of Water Conditioning System

This Graver water treatment with hot zeolite was chosen because it offered these advantages over a hot process softener with hot phosphate after-treatment:

1. **Lower hardness in feedwater.**
2. **Lower $CO_2$ in steam because of lower alkalinity.**
3. **Lower chemical operating costs.**
4. **Low silica in feedwater.**
5. **A uniformly low hardness in feedwater with possible rapid variations in raw water composition.**

The plant includes a single GRAVER SPHERICONE Hot Process Sedimentation Tank ... also the largest in the world ... to handle the entire water supply. This exclusive tank design gives greatest clarity of effluent, and at the same time provides greatest economy in steel and manufacturing cost. • **Write for further information on the application of this type of GRAVER Water Conditioning System to your own feedwater needs.**

BY GRAVER

### Facts about the GRAVER equipment in this plant

- One GRAVER SPHERICONE Hot Process unit 43 ft 6 in dia x 60 ft high.
- Six GRAVER Hot Zeolite Softeners, each 10 ft dia x 5 ft 6 in high.
- Twelve GRAVER Anthrafilt Filters, each 11 ft dia x 5 ft high.
- GRAVER Chemical Feeders.

●●●●●

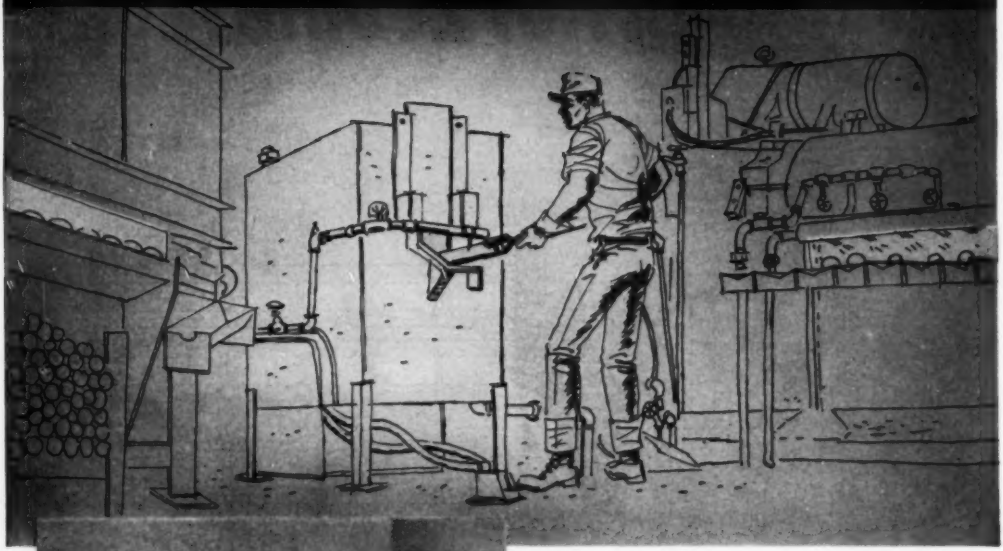
Write for Technical Articles: "Hot Zeolite Softening" and "Factors in Hot Process Softener Design and Operation."

GRAVER

**GRAVER WATER CONDITIONING CO.**
*Division of Graver Tank & Mfg. Co., Inc.*
**216 WEST 14th STREET, NEW YORK 11, N. Y.**

GW 459 A

# KNOCKS OFF SCALE IN 1½ SECONDS!



This automobile plant uses two BJ Hydropress Pumps for descaling. One pump services as many as 10 cabinets (with 5 operating at once).

## *Auto industry uses BJ Hydropress Pumps to descale forged parts hydraulically!*

Manual or mechanical descaling operations are time-taking and profit-robbing. Especially when a product requires several descalings during production. You'll save time, money and rejects by descaling hydraulically with BJ Hydropress pumps.

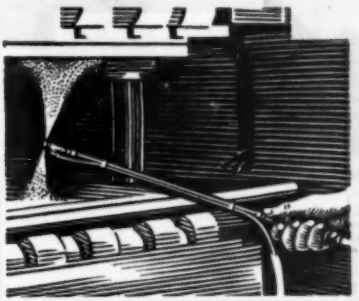
Here's one of the many examples of modern hydraulic descaling as used by the automotive industry. During the heating of axle bars prior to forming, scale is created and must be removed. This is done in a hydraulic descaling cabinet. As the bar is inserted, a lever is tripped and high velocity water at 1500 to 2000 psi hits the bar from 3 to 5 nozzles. Scale is removed in 1½ seconds! Afterwards the hot bar is placed on a forming roll.

The BJ Hydropress pump is ideal for this type of work because of its unique construction features. It does not require relief valves, accumulators or extra heavy fittings and piping. Its double volute design creates inherent balance at all heads and capacities. Its vertical construction allows the use of a simple foundation and a minimum of floor space.

**For more information call your local BJ sales engineering office or write:**

**Byron Jackson Co.**
Since 1872
**P. O. Box 2017, Terminal Annex, Los Angeles 54, California**
**Sales Offices in Principal Cities**

# NO SMOKE... NO FUMES in Hot Forging with... "dag" Colloidal Graphite



**"Dag"** colloidal graphite dispersed in water eliminates smoke and fumes in hot forging operations . . . greatly improves working conditions. The lubricating properties of colloidal graphite are superior, too, giving increased production . . . reduced die wear . . . better finish . . . and usually a saving in steel stock.

The uses of **"dag"** colloidal graphite for hot forging operations are fully explained in a specially prepared article entitled "Forging Die Lubrication". Copies are available without obligation. Write today to Acheson Colloids Corporation, Port Huron, Michigan, for Bulletin #750-17J.

**dag**
DISPERSIONS®

## Acheson Colloids Corporation

Port Huron, Mich.

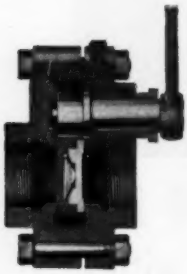
...also Acheson Colloids Limited, London, England

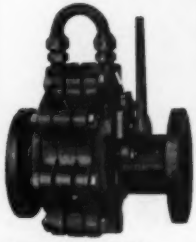
# EVERLASTING VALVES

## mean "Everlasting" Protection on these duties

**GENERAL SERVICE**

Wherever frequent use and quick operation is required for any liquid or gas at pressures up to 300 psi. These valves have outside stuffing box and gland.





**STEAM JACKETED**

Assure continued free flow of any material which congeals at ordinary temperatures.

**FIRE PROTECTION**

Closing type for inflammable liquid emergency shut-off, or opening type for deluge or drainage, assuring immediate and positive action with weighted pendulum step.

**BOILER BLOW-OFF**

Quick-opening, also hand-wheel operated, Angle and "Y" types meeting ASME Code requirements for pressures up to 600 psi.

**BOILER WATER COLUMN**

With indicator and locking device. Meets ASME Code requirements.

### EVERLASTING FEATURES

**For more than 40 years, EVERLASTING VALVES have been known for their ingenious design, simple sturdy construction, and long trouble-free life with low maintenance expense. Some of their distinctive features are:**

***Quick-Action*** **. . . opened or closed with less than a quarter turn of the operating lever.**

***Straight-Through Flow*** **. . . the disc cannot become loose and accidentally check the flow.**

***Drop-Tight Seal*** **. . . constant contact of disc and seat at all times prevents dirt or scale from getting between.**

***Self Regrinding*** **. . . the disc rotates on the seat with each operation, thus regrinding the sealing surfaces.**

***No Wedge Action*** **. . . all parts move between parallel faces.**

**Write for bulletin describing EVERLASTING VALVES in detail.**

**EVERLASTING VALVE COMPANY, 49 Fisk Street, Jersey City 5, N. J.**

**Everlasting Valves**

Trade-Mark "EVERLASTING" REG. U.S. PAT. OFF.

*for everlasting protection*


# News

**of men and companies**

*( Continued from page 118 )*

**The Barrett Div., Allied Chemical & Dye Corp.**—The H. K. Ferguson Co. was awarded the contract to build a new applications research building in Edgewater, N. J. Total cost is approximately $500,000.

**Eli Lilly & Co.**—Construction has started on a multi-million dollar antibiotics plant on a 370-acre site southwest of Lafayette, Ind. The H. K. Ferguson Co. is in charge of construction.

**Titanium Metals Corp. of America**—Construction already has started on a $14-million plant for the production of metallic titanium, to be located at Henderson, Nev.

**General Motors Corp.**—Chevrolet Motor Div. will build 1,000,000 sq ft of new buildings in the Buffalo area to provide additional manufacturing capacity for aviation engines.

**Diamond Alkali Co.**—Plans were authorized for an expansion project to cost several hundred thousand dollars at its silicate of soda plant at Dallas, Tex.

**Ford Motor Co.**—The Turner Construction Co. in association with Barton-Malow Co. have been awarded a contract for a $6,000,000 addition to the existing plant at Ypsilanti, Mich., for the production of aircraft engine fuel injection systems. Airplane wing sections will be produced in 1600x650 ft plant now under construction at Claycomo, Mo.

**General Electric Co.**—Construction has begun on its new multi-million dollar Appliance Park at Buechel, Ky. Turner Construction Co. and Struck Construction Co. are joint contractors.

**The B. F. Goodrich Co.**—B. F. Goodrich Chemical Co., a div., will construct a plant costing $5,000,000 in Calvert City, Ky.

**Fairchild Engine & Airplane Corp.**—Contract for construction of a $2,000,000 manufacturing building at Bay Shore, L. I., has been awarded to John W. Harris Associates, Inc. The plant will be used by the Stratos Div. for manufacture of aircraft accessories.

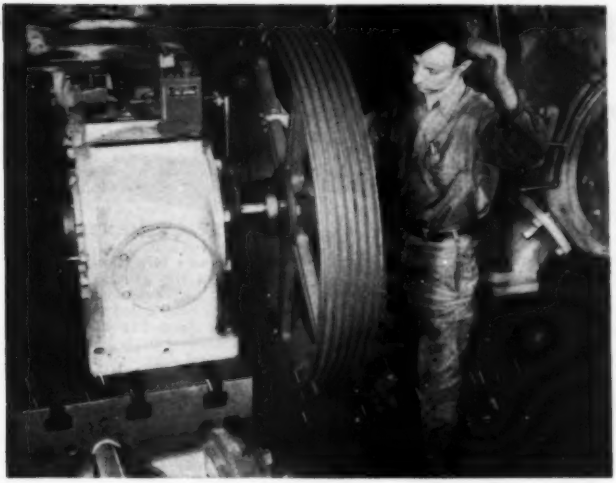
**Sun Oil Co.**—Plans for construction of a $10,000,000 refinery to process 10,000 to 15,000 barrels a day at Sarnia, Ontario, Canada, were announced.

**Whitney Chain Co.**—New plant in Longview, Tex., will be erected and equipped for the manufacture of chains and sprockets.

**Standard Steel Specialty Co.**—The Woodruff Key Div. of the Whitney Chain Co. has been purchased. Additional facilities will be established through a plant addition at Hammond, Ind.

**Worthington Pump & Machinery Corp.**—A $500,000 modernization of the

*( Continued on page 124 )*



# Pick the V-Belt Sheave

## *which all industry likes best*

QD
TRADE MARK

* Split hub is clamped to shaft. Heavier taper-bored rim slides easily over tapered hub—no keyway obstruction on cone surface. Positive press fit on shaft. Large, long pull-up bolts also used as jack screws to remove rim.

Here's a 26-word description of the V-belt sheave that is used more than any other.*

Two parts for easy handling—separately or together. Split hub and tapermated rim make mounting easy. No realignment problem—clamped hub stays put while changing rims.

That's Worthington's QD—the original tapered cone-grip sheave that's preferred by men who have to install or change sheaves. The QD is *easy to get on, easy to get off, yet always tight on the shaft* —tighter than any other sheave on the market. Hubs for every bore—lower inventory cost.

For your machines, pick Worthington Multi-V-Drives with QD sheaves and Worthington-Goodyear EC Cord V-belts.

Complete range of stock sizes—prompt shipment from distributors everywhere.

**In addition to being one of the largest-selling sheaves, the popular Worthington QD design is licensed to many other sheave manufacturers. For your protection, dimensions are standardized to permit interchangeability.*

# but the distributor "came through"

A hydro-electric plant, crippled by drought, was threatened with losing its franchise; was given 60 hours to bring its service up. Two Diesel engines were about to arrive when somebody remembered to order the V-belt drives.

A call to **Anderson-Crane Rubber Company**, Worthington distributor in Minneapolis, located four large D-section QD sheaves and 25 Worthington-Goodyear steel cable V-belts. These were rushed by car at night to the power plant, arriving just ahead of the engines. Within 24 hours, the plant was producing full power.

**Once again, the Worthington distributor was *on the job*—with the needed supplies and the prompt service!**

# WORTHINGTON

THE GOOD RIGHT HAND OF INDUSTRY

**POWER TRANSMISSION:** sheaves, V-belts, variable speed drives

**PUMPS:** centrifugal, power, rotary, steam

**AIR COMPRESSORS:** water-cooled, air-cooled

Worthington Pump and Machinery Corporation
Multi-V-Drive Sales Division
Buffalo, New York

Send Bulletin V-1400-B7F on Worthington Multi-V-Drives.

Name.....

Company.....

Address.....Zone....State...

MV.1.3

# REDUCE PUMP REPAIRS 4 WAYS

1. **Prevent STEM and SPRING breakage.** Exclusive double shock absorber built into Sims valves stops impact shock.
2. **Stop wear.** Long guide of ROTATOR prevents cocking of DISC—assures even opening.
3. **Keep seating surfaces leak free.** Only Sims guarantees the valve DISC will rotate every time it lifts.
4. **Stop valve slam and knock.** Quiet operation is gained by cushioning moving parts and cutting resistance to flow through the SEAT ... with patented **inclined ribs.** This reduction of resistance allows cylinders to fill completely. Pump capacity is increased 20%.

**Sims valves are made in sizes from 2¾" to 15¼" to fit any reciprocating pump. Valves supplied ready to install—cast in individual units or in complete plates.**

**SIMS PUMP VALVE CO., INC.**

New catalog shows how Sims valves fit any pump—how they work—efficiency and comparison charts. Send for your free copy today.

**145 HUDSON ST., NEW YORK 13, N. Y. • M & M BLDG., HOUSTON, TEXAS**

**EVERY POUND OF PALMETTO® BRAIDED IS BUILT FOR LESS DOWN TIME**

**It pays to pack well, for the cost of frequent repacking and equipment failure runs all out of proportion to the price of dependable packing. Palmetto's Braided will show you that economy. Every pound built for 600 F superheated steam service. That means bonus performance at all lower temperatures. Structure of high grade, high tensile 12 cut Canadian white asbestos yarn — quality that counts for better wear. Each strand lubricant-impregnated before braiding to insure self-lubricating performance. That means less friction, less maintenance, longer life.**

**Investigate Braided's pliable, non-scoring, non-hardening service — and the complete line of Palmetto Self-Lubricating Packings. Write for Bulletin LP-10.**

**GREENE, TWEED & CO.**
**NORTH WALES, PENNSYLVANIA**

*Contact your fully-stocked Palmetto distributor on all packing problems ... ask him about our special tools.*


# News

**of men and companies**

*( Continued from page 122 )*

Oil City, Penn., plant is planned. Includes re-equipping the present foundry and establishing a new electric power supply.

## APPOINTMENTS

**Allis-Chalmers Mfg. Co.**—J. L. Singleton, v-p of the general machinery div., and R. S. Stevenson, v-p of the tractor div., were elected to the board of directors succeeding the late W. Geist and W. C. Johnson. H. S. Bimpson is named to the office of the director of engineering of the general machinery div. as consulting engineer. L. A. Watts retired as manager of the service and erection section of the general machinery div. C. B. Smith, supt. of the Atlanta district is named successor.

**American Vitrified Products Co.**—E. L. Miller, v-p and general manager, was elected to the board of directors. J. L. Brown, former general sales manager, was named v-p and will continue in direct charge of sales in all divisions.

**Borg-Warner Corp.**—Capt. E. E. Roth, USN, Ret., was named assistant to the works manager, defense div. of the Kalamazoo works of the Ingersoll Products Div.

**Bowser, Inc.**—E. C. Marsh, president of the Fort Wayne Div., announced his resignation. J. P. Orchard, executive v-p, was elected to succeed as president.

**Cleaver-Brooks Co.**—F. A. Hopp was appointed advertising manager.

**F. A. Hopp** **C. S. White**

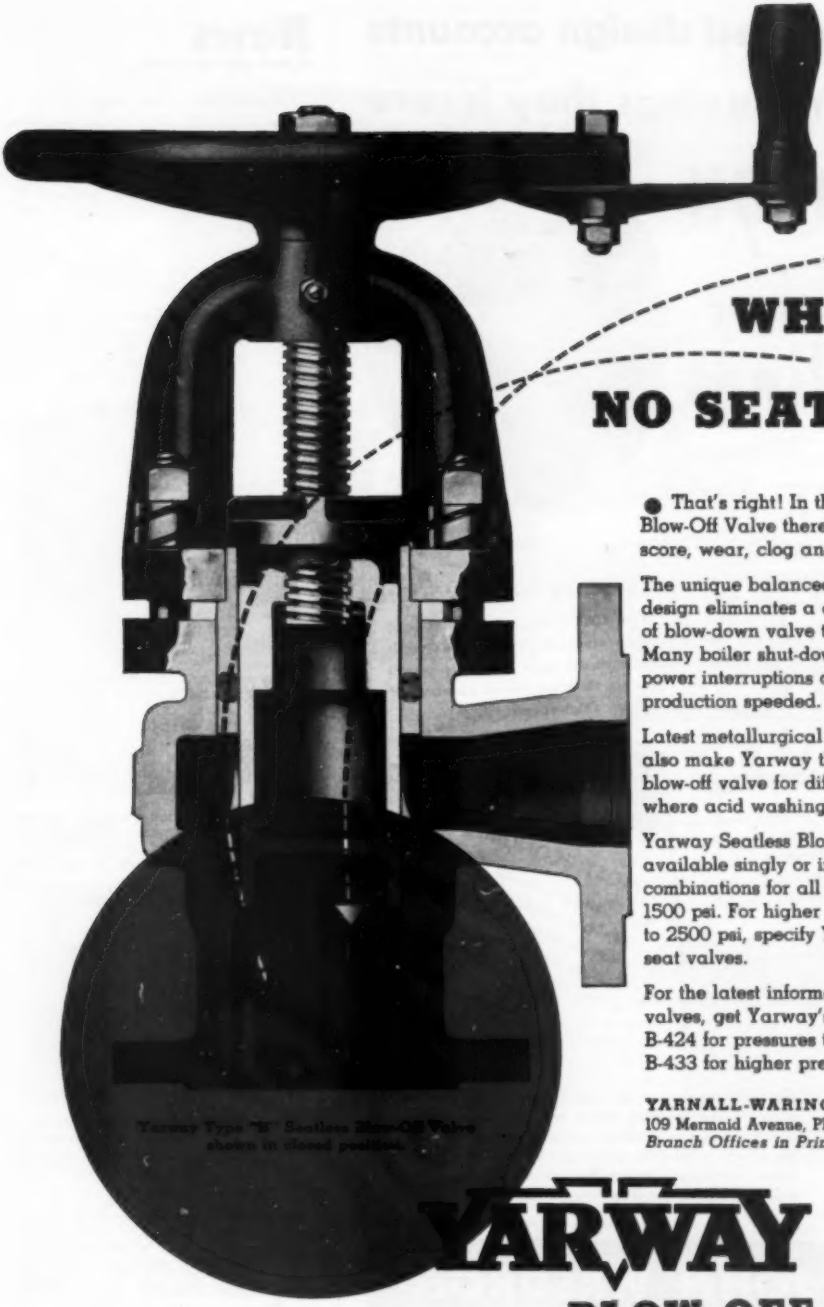
**Dearborn Chemical Co.**—C. S. White, formerly manager of the eastern div. water treatment dept., replaces the late H. J. Cornell as manager eastern div.

**The Cleveland Worm and Gear Co.**—D. H. Rowe was appointed advertising manager of the company and its affiliate, the Farval Corporation.

**Corning Glass Works**—Dr. E. U. Condon was named director of research and development, co-incident with his resignation, effective Sept. 30, as director of the National Bureau of Standards.

**Cummins Engine Co., Inc.**—R. E. Huthsteiner, former executive v-p, was elected president succeeding J. I. Miller, who becomes chairman of the

*( Continued on page 126 )*



Yarway Type "S" Seatless Blow-Off Valve shown in closed position.

# WHAT?

# NO SEAT?

● That's right! In this Yarway Blow-Off Valve there is no seat to score, wear, clog and leak.

The unique balanced sliding plunger design eliminates a common cause of blow-down valve trouble—the seat. Many boiler shut-downs are saved . . . power interruptions avoided . . . production speeded.

Latest metallurgical improvements also make Yarway the ideal blow-off valve for difficult service where acid washing is used.

Yarway Seatless Blow-Off Valves are available singly or in tandem combinations for all pressures up to 1500 psi. For higher pressures up to 2500 psi, specify Yarway Stellite-seat valves.

For the latest information on blow-off valves, get Yarway's newest catalog—B-424 for pressures to 400 psi, B-433 for higher pressures.

**YARNALL-WARING COMPANY**
109 Mermaid Avenue, Philadelphia 18, Pa.
*Branch Offices in Principal Cities*

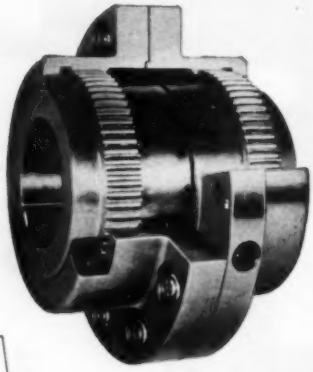
# YARWAY

## BLOW-OFF VALVES

***STOP BLOW-DOWN TROUBLES—KEEP BOILERS ON THE***

## an advanced design accounts for the savings they insure

# WALDRON *Improved* GEAR TYPE Couplings



**LARGER BORE**

New WALDRON design affords a larger maximum bore to permit use of larger shafting, smaller physical capacity for same size shaft with reduced rotating weight.

**STRONGER CONSTRUCTION**

WALDRON cover sleeve is one solid forged steel unit. With *no welded parts* the accurate gear in sleeve cannot become distorted. Added assurance of safety at high speeds.

**EXTRA PROTECTION**

WALDRON oil and dust seal, impervious to mineral lubricants, hermetically seals against oil oxidation. Ever present oil film carries load with no possibility of wear from metal-to-metal contact.

**MOST ECONOMICAL**

Their past performance records coupled with new design and construction features combine to prove WALDRON Couplings the most economical to buy as well as use for longer service life.

The same engineering skill that developed the improvements on gear coupling design is always available for special application couplings and any other service when you specify WALDRON Couplings. Write for this helpful folder explaining coupling features which give added insurance against coupling failure. No obligation.

**JOHN WALDRON**
CORPORATION
New Brunswick, New Jersey
*Authorized Sales Representatives in Principal Cities*


# News
**of men and companies**

*( Continued from page 124 )*

board. C. L. Cummins, founder, was named honorary board chairman.

**Henry Disston & Sons, Inc.**—G. E. Hopf is manager of the newly created Marketing Div.

**Elliott Co.**—C. L. Harvey has recently joined the headquarters sales staff of the large motor div.

**General Controls Co.**—S. D. Andrews is appointed branch manager of the Dallas, Tex. office. He replaces R. Farmer who will return to the Glendale plant as a factory engineer.

**General Electric Co.**—Dr. L. T. Rader was made manager of engineering of the Control Divs. He appointed H. L. Palmer as assistant to the manager of engineering of the Control Divs. and B. Cooper as division engineer of the Electronics and Regulator Engineering Div. E. H. Howell has been appointed assistant manager of the East Central district of the Apparatus Marketing Div. Dr. K. H. Kingdon was named manager of the newly created Technical Div. and W. H. Milton, Jr. manager of the newly established Operating Div. in the Knolls Atomic Power Lab. W. E. Saupe was appointed operation manager, and W. Pruessman was named manager of manufacturing of the Schenectady Steam Turbine and Generator Divs. L. S. Gleason is now supt. at the Chemical Department's plastics molding plant at Decatur, Ill. A. T. Bourgault of the Chemical Div. has been appointed manufacturing analyst for the Chemical Materials Dept.

**The B. F. Goodrich Co.**—E. T. Gregory was named manager of flat belting sales, succeeding A. C. Mack, resigned, and has been succeeded as operating

**D. E. Schlemmer** **E. T. Gregory**

manager of the Industrial Products Sales department by D. E. Schlemmer. R. Price was appointed sales manager of the Plastic Products Div. with headquarters in Marietta, Ohio.

**Industrial Tape Corp.**—S. J. Geoghegan has been appointed v-p in charge of materials control of this subsidiary of Johnson & Johnson.

**Mackintosh-Hemphill Co.**—G. Breza has been appointed chief engineer.

**Miller Electric Mfg. Co.**—D. R. Warner is the new Near-Western district sales manager. His headquarters will be centered near Denver, Col.

*( Continued on page 128 )*

Patented metered air-oil injection provides perfect fuel combustion — cuts fuel costs.
Swirling flame produces higher speed of flame travel — more efficient heat transfer.
Dry-pan baffle insures low moisture steam.
Target ring reforms flame to insure complete combustion.
STEAM-PAK
STEAM-PAK
YORK POWER
GENERATOR
A PRODUCT OF YORK-SHIPLEY
STEAM in a PACKAGE

# You Get TREMENDOUS SAVINGS!

**Savings From Manufacturing Advantages:**

Steam-Pak Generators are factory engineered, built and pre-tested—manufactured on production line basis for quality and lowest possible cost.

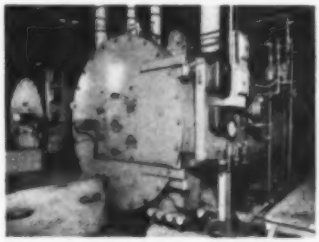
**Savings From Installation Advantages:**

Mechanical draft eliminates expensive chimney—packaged unit requires no special foundation—flexibility permits multiple installation—installation costs are cut to a minimum.

**Savings From Operating Advantages:**

Automatic controls eliminate high labor costs—faster starting with faster steam saves costly waiting time and efficient firing cuts fuel costs.

Thousands of users are evidence of the tremendous savings found with Steam-Pak Generators. They are built in sizes from 15 h.p. up, for low or high pressure, steam or hot water, for light or heavy oil, combination gas and oil, or straight gas.



*Multiple installations such as this one, costing about* $10,000, *save an average of* $1,000 *per month in fuel and labor alone.*

**YORK SHIPLEY**

916 JESSOP PLACE · YORK, PENNSYLVANIA · PHONE 7861

*Industrial Division*

INDUSTRIAL DIVISION YORK POWER — YORK HEAT RESIDENTIAL DIVISION

Steam-Pak Generators · Vertical Boilers · Rotary Oil Burners · Conversion Oil Burners · Conversion Gas Burners · Water Heaters · Winter Air Conditioners · Tubeless Boiler Units

# With This NEW Improvement Niagara "No-Frost Method" puts you a big step ahead in trouble-free, automatic refrigeration or freezing

Niagara "No-Frost Method" keeps frost and ice COMPLETELY OUT of your cooling, chilling, freezing or cold storage.

It uses Niagara No-Frost Liquid Spray to keep frost and ice from ever forming. It gives you, automatically, refrigeration with no defrosting, and full capacity NEVER cut down by ice building up progressively on refrigeration coils.

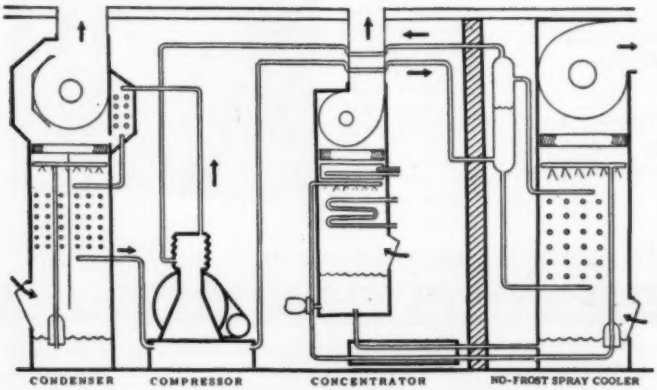
Now, a NEW design No-Frost Liquid concentrator, using a new principle, takes away moisture as fast as it is condensed by evaporating it at low temperature — not boiling it away at high temperature. It has 14 times the capacity of the old method per dollar of investment — one concentrator will handle a battery of high capacity spray coolers.

This gives you more refrigeration at lower cost; less machinery in less space. You operate at high suction pressure, saving power and wear and tear on compressors.

The extra capacity and lower cost both for equipment and operating makes this method advantageous for every type of refrigeration use — both for freezing and for moderate temperatures — for large "live" loads as in meat chilling or in fruit and vegetable pre-cooling — for rooms that are filled and emptied of product daily, such as milk rooms and terminal storage warehouses.

You get true trouble-free refrigeration . . . No brine . . . no salt solution . . . no dirt . . . no mess . . . It is entirely clean; you get rid of dirt and odors. You reduce both equipment and operating costs.

For complete information write to the Niagara Blower Company, Dept. IP 405 Lexington Avenue, New York 17, New York.




A simple method, easily maintained. Saves a third of your refrigeration cost. Ask for Niagara Bulletins 118 and 119.


# News

**of men and companies**

*( Continued from page 126 )*

**Minneapolis-Honeywell Regulator Co.**—C. W. Bowden, Jr., was named chemical industry manager for the Brown Instruments Div. Although Bowden will specialize on ordnance and defense projects related to the chemical industry, he will continue in a consulting capacity in the central-stations and power field.

**Monsanto Chemical Co.**—Robert M. Aude is made production superintendent of the new Plastics Div. plant in Addyston, Ohio.

**Pennsylvania Flexible Metallic Tubing Co.**—W. Townsend has been advanced to the post of v-p, and C. W. Strine was appointed treasurer. C. W. Young, former plant production manager, was named v-p in charge of production. E. Haegele was appointed master mechanic.

**National Electric Products Corp.**—R. C. Bennett, Jr., v-p, was appointed a member of the industry advisory committee on price regulations affecting the low voltage electrical distribution equipment industry. W. A. Mallory has been named manager of the mechanical connectors dept. He also will assist in managing the busway dept.

**National Gypsum Co.**—W. J. Sprau was named to the position of production engineer for its four paper plants. Former Manager J. Manofsky has retired from active managership of the Niles, Ohio, metal lath plant and has been succeeded by J. G. Stapler.

**Pettibone Mulliken Corp.**—W. E. Madden was named director of sales and J. M. Hume has been named assistant director.

**H. K. Porter Co., Inc.**—L. L. Garber, v-p, was appointed general manager of the Hinderliter Tool Company Div.

**Southern Coal Co.**—Frank H. Westlake has joined the company and will represent it throughout Ohio and Michigan.

**United States Rubber Co.**—H. E. Humphreys, Jr., president, has been elected chairman of the board of directors. He will continue as president.

**Vapor Heating Corp.**—G. W. Schroeder has been appointed purchasing agent for the company and its subsidiary, Roth Manufacturing Co.

**Westinghouse Electric Corp.**—F. Thornton, Jr., engineering manager of association activities, has retired after 42 years with the company. He is succeeded by H. Blackmon.

**Worthington Pump & Machinery Corp.**—V. de P. Gerbereux is made manager of the Centrifugal Pump Sales Div. He succeeds A. H. Borchardt who was recently elected v-p in charge of centrifugal, reciprocating and verticle turbine pump sales.

# BRUTE STRENGTH FOR TOUGH HAULS

## QUAKER CONVEYOR BELTING

### for more tons hauled . . . lower cost per ton

No haul too tough . . . no coal too rough for Quaker Conveyor Belts. That's why they are used in the leading mines throughout the nation. Belts that assure minimum of maintenance and low cost conveyor operation.

Quaker Conveyor Belts are scientifically made of ply upon ply of strong, specially woven cotton duck tightly bonded together to prevent internal friction while flexing. Covers are made of resilient, torture-tested, long-lasting live rubber that resists constant abrasion, withstands continuous flexing. Precision controlled vulcanization moulds plies and covering into a belt of brute strength ready to take the toughest of loads on the heaviest hauls—defies wear, separation, breakdown.

For maximum tonnage hauled, equip your conveyors with Quaker belts. There's longer life built into each one . . . more service in every foot. Call your nearest Quaker Distributor for performance-proved Quaker Industrial Rubber Products.



**FOR POSITIVE POWER**
Quaker Transmission Belting is pre-tested for maximum horsepower transmission. Available for all types of drives—from fractional horsepower to the largest installations.



**HOSE FOR RUGGED WEAR**
There's a Quaker Hose for every use in the coal industry—from the air hose on the lowest level to the water hose in the washer.



**FOR SAFETY . . . ALL WAYS**
Quaker's Mine Trolley Cable Guard offers protection for mine cables. It is specially compounded of synthetic rubber to resist mine damp, acid and water. It is also resistant to fire which adds an extra safety margin and prevents breakdown.

**QUAKER RUBBER CORPORATION**
*Division of H. K. Porter Company, Inc.*
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# QUAKER RUBBER PRODUCTS
*custom made for every industrial use*

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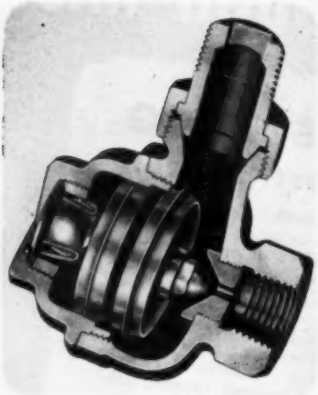

**Built for Long Life in Medium and High Pressure Service**

**For steam pressures between 15 and 100 pounds gage, your safest choice is a B&J Medium or High Pressure Thermostatic Trap. These traps are especially effective for use with coffee urns, sterilizers, general cooking apparatus, process fixtures and laundry equipment where pressures exceed 15 pounds.**

**Heavily constructed, B&J Medium and High Pressure Traps are designed particularly for such uses. Removable stainless steel seat and monel valve piece, the only parts that will ever wear out — thermostatic element and seat — can be replaced quickly and easily.**

**And remember, too: every single item produced by Barnes & Jones is thoroughly and exhaustively checked and must pass our most exacting requirements before it ever leaves our plant. Moral: you're *bound* to be *right* with Barnes & Jones.**

B&J

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**128 BROOKSIDE AVE., BOSTON 30, MASS.**
*Representatives in all principal cities*

# Reviews of recent books . . .

***Recent books, published for men responsible for The Engineered Plant Services, are reviewed here. Write to the publisher for those in which you are interested***

### V-Belt Drive Standards

"Engineering Standards for Multiple V-Belt Drives", published by the Multiple V-Belt Drive & Mechanical Power Transmission Association, 7 West Madison Street, Chicago 2, Illinois and The Rubber Manufacturers Association, 444 Madison Ave., New York 22 N.Y. Illustrated with drawings and charts. 16 pages. Price, Two copies $1.00.

The Rubber Manufacturers Association, Inc. and the Multiple V-Belt Drive & Mechanical Power Transmission Association today announced the completion and issuance of a 16-page manual of recommended "Engineering Standards for Multiple V-Belt Drives", as developed and approved by the technical committees of both associations.

The "Associations" expect that the new standards manual will be of material assistance to the thousands of users of multiple V-belt drives. The data in the manual are based on the latest engineering opinion and research. The manual indicates the proper sheaves and belt to be used for the attainment of optimum efficiency and economy of the complete drive in relation to the particular duty required.

### Corrosion

"Corrosion—Causes and Prevention", by Dr. Frank Newman Speller. Published by the McGraw-Hill Book Co., 330 West 41st Street, New York 18, N. Y. Illustrated. Price, $10.00.

The Third Edition of Corrosion—Causes and Prevention is written with particular reference to the ferrous metals. This book further discusses the theory of corrosion and describes the various methods for prevention. Highlights are coverage of cathodic protection, an important new factor, and inclusion of the latest available information on biological influences and newly developed corrosion preventives.

First part of this reference volume describes the known facts about corrosion and the generally accepted electrochemical theory. Controlling factors that contribute to the various kinds of corrosion are described in simple language, free of mathematical and thermodynamical terms. The author classifies these types of corrosion according to the controlling factors that act external to the metal: temperature, rate of motion, films and coatings, concentrations of dissolved substances, acids, alkalies, oxiding compounds, etc.

Part two is devoted to a detailed coverage of corrosion—prevention in the atmosphere, underwater, in closed water systems, in steam generators, in steam and hot-water heating systems, in the chemical industries, and underground. Pertinent data on the calculation of corrosion rates, conversion tables, additional tests for determining corrosive activity, alloy analysis and a glossary of terms are included.

### Plant Maintenance

"Techniques of Plant Maintenance —1951", published by Clapp & Poliak, 341 Madison Ave., New York 17, N. Y. Illustrated. 228 pages. Price, postpaid, $6.00.

An extensive discussion of recent developments in problems of plant maintenance, this book is a companion piece to "Techniques of Plant Maintenance—1950". It also contains the proceedings of the Plant Maintenance Conference held in conjunction with the Cleveland Plant Maintenance show. The new volume is printed and bound instead of mimeographed. More than forty nationally known experts in the field of maintenance contributed papers. The book contains 48 tables, diagrams, illustrations, graphs and charts. One of the features is a series of questions and answers submitted after each of the 12 sessions. In all, 544 questions put to the speakers are answered.

Subjects covered include preventive maintenance, inspection procedures and frequencies, records and reports, training personnel for maintenance, organization and management for maintenance, maintenance costs, incentive payment of maintenance workers, planning and scheduling maintenance operations, applied lubrication in industry, housekeeping, painting and decorating, floors and standards of sanitation.

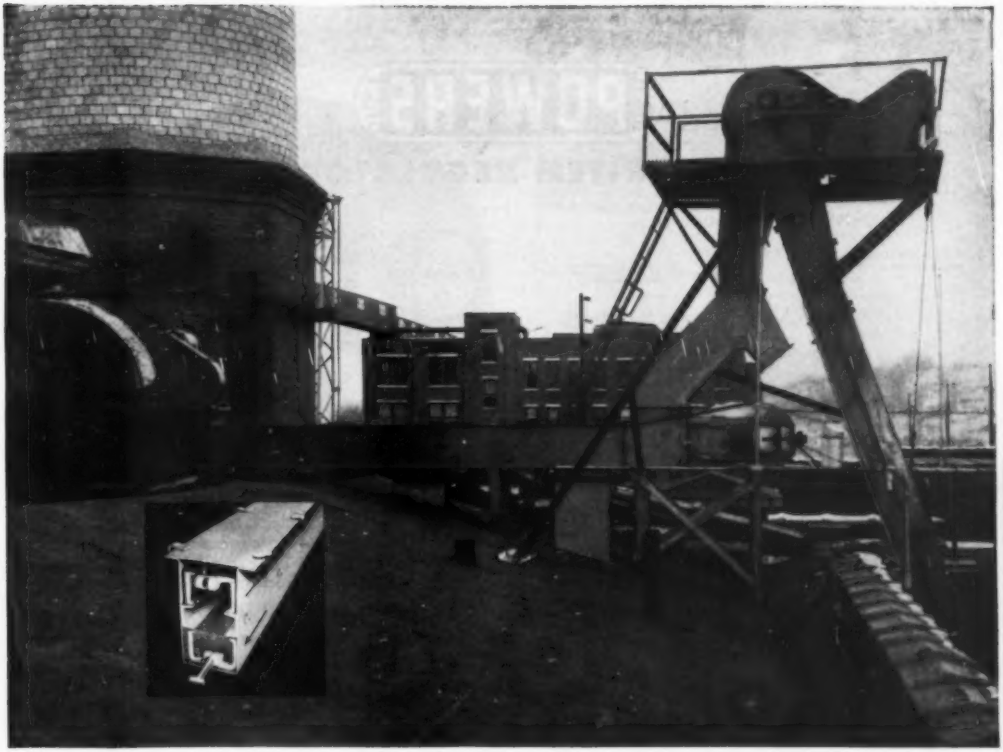
Specialized discussions on maintenance of electrical equipment, power plant and heating equipment, problems of the small plant, selection and maintenance of lighting equipment, maintenance in chemical plants, in paper and paper products plants, in food processing plants, and in metal working plants are included.

### Nomographs

"Nomographic Charts", by C. A. Kulmann. Published by McGraw-Hill Book Co., 330 West 41st Street, New York 18, N. Y. Illustrated. 250 pages. Price $6.50.

This book contains 92 charts, all designed specifically to simplify the solution of time-consuming computation problems encountered daily by engineers. Preliminary solutions to problems can be solved without looking up, in tables, the values of the various items. According to the author, these charts, some of which he has used for over 20 years, eliminate a good percentage of routine work and provide,

***( Continued on page 133 )***



# Coal has to STEP FAST at this power plant

**Twenty-five tons of coal per hour—from cars to bunker—is the proved performance of this S-A REDLER installation, requiring very little space and minimum supports. It is typical of the way S-A engineers, with more than half a century of specialized experience to draw upon, solve specific material handling problems. . . . If you have a question on moving bulk materials you will save time and money—and assume no obligation—by talking it over with qualified S-A engineers. Your inquiry is respectfully invited.**

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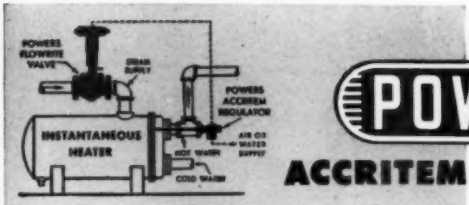
Endicott, N. Y.

*Roof top view shows head end of REDLER elevator transferring coal to a 20-foot long horizontal REDLER conveyor which discharges through four outlet chutes into boiler room bunker located directly below roof. Coal is received in a track hopper, is fed to an S-A KNITTEL ring-type crusher and then delivered to the feed section of the REDLER elevator. Coal placed on yard storage can be reclaimed to a special hopper for re-entry into the REDLER handling system.*

1901-1951
*50 years experience with bulk handling*
**STEPHEN S-A ADAMSON MFG. CO.**
21 Ridgeway Avenue, Aurora, Illinois · Los Angeles, Calif. · Belleville, Ontario

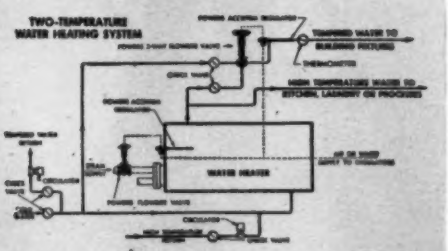
**DESIGNERS AND MANUFACTURERS OF ALL TYPES OF BULK MATERIALS HANDLING EQUIPMENT**

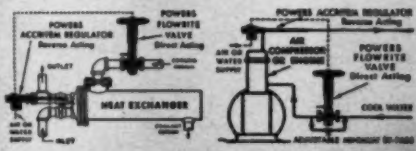


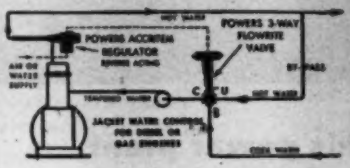

# POWERS

## ACCRITEM REGULATOR

### Only a few of many uses

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POWERS 3-WAY FLOWRITE VALVE
JACKET WATER CONNECTIONS FOR DIESEL OR GAS ENGINES

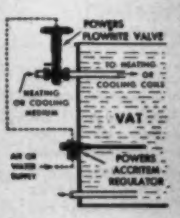
### *Gives*

## Accurate, Low-Cost Heat Control

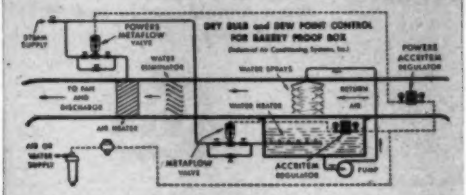
Use Accritem Regulators to control diaphragm operated valves or dampers. They save labor, stop losses caused by over-heating and have the following—

**IMPORTANT ADVANTAGES**

- ***Adjustable Sensitivity*** and over-heat protection.
- ***Calibrated Dial*** temperature adjustment.
- ***Simple, Rugged Construction*** withstands vibration and insures many years of reliable service.
- ***Temperature Ranges*** 50 to 250° F. and 150 to 350° F.
- ***Easy to Install*** Requires 15 lb. supply of compressed air or water for its operation.
- ***Small Size***—regulator head is only 2⅞" x 3⅝", sensitive bulb is 12" long with ½" I.P.S. connection.



**FLOWRITE and METAFLOW**
**Diaphragm Valves**
**controlled by a POWERS**
**ACCRITEM HEAT REGULATOR**
**provide an unbeatable combination for *better control* and *lower maintenance***

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**60 Years of Temperature and Humidity Control**

*( Continued from page 130 )*

in many instances, for an even greater accuracy than can be achieved even by slide rule calculations.

To present this timesaving data in readily usable form, the author uses a variety of chart designs. There are alignment-type charts, intersection-type (graphical coordinates and curves) and combinations of these two kinds. When the problem involves wide ranges in magnitudes of the variables, they are presented with the shortest practical numerical scaling but include auxiliary scalings to take care of the decimal point. Some of the charts, chiefly those on hydraulics, are based upon formulae derived from observations and laboratory tests or upon correlated data on successful designs.

Included are five categories of frequently-used engineering computations; Function Scales; Hydraulics and Hydraulic Equipment; Mechanics; Thermodynamics and Electrical.

**Fuels and Combustion**

"Fuels and Combustion Handbook", by Allen J. Johnson and George H. Auth. Published by McGraw-Hill Book Co., 330 West 42nd Street, New York 18, N.Y. Illustrated. 915 pages. Price $12.50.

This handbook covers every aspect of combustion engineering—giving engineers and operating men alike the information needed for most efficient and economical fuel utilization. The characteristics, properties and uses of all solid, liquid, and gaseous fuels—a complete coverage of the data necessary for selecting the best fuel for specific job and using it most efficiently are given, plus a working knowledge of all important combustion machinery—showing how to design and operate and how to maintain equipment under actual operating conditions.

Also covered are combustion processes, fuel handling and storing methods, and many other subjects. The book considers the factors concerned with selecting and using the various types of fuels—discusses the way they are used in combustion processes—shows how they are treated and prepared for use, as well as how they are handled and stored—and deals extensively with the transfer and generation of heat and power. Wherever possible, tables and charts are used instead of formulas.

**Mechanics**

"Simplified Mechanics and Strength of Materials" by Harry Parker. Published by John Wiley & Sons, 440 Fourth Ave., New York 16, N.Y. Illustrated. 275 pages. Price $4.00.

The sixth volume in his well-known "Simplified" series follows the pattern of other books in the series. It contains an elementary treatment of the subject for use by practical men interested in mechanics and construction. Using only simple arithmetic and algebra, the author concentrates on material bodies in which there is no motion. After a thorough general survey of all the mechanical forces to be considered, their specific applications to columns, rivets and welds, shafts, pipes and tanks, concrete, retaining walls and dams are discussed.

A wide variety of illustrative problems is provided along with tables of allowable stresses, properties of sections, and other useful data.

# Meetings and exhibitions

***Announcement of coming meetings that will aid executives and engineers in planning itineraries. For additional information, please write sponsors of meetings***

**SEPTEMBER**

**National Instrument Conference and Exhibit** will be held in the Sam Houston Coliseum in Houston, Texas, September 10-14. Write the Instrument Society of America, 921 Ridge Ave., Pittsburgh 12, Pa., for information.

**Air Pollution and Smoke Prevention Assn. of America** will hold its East-Central meeting in Detroit, Sept. 13-14. For further information write J. W. Shaw, Program Chairman, Detroit Smoke Abatement Bureau, 112 E. Jefferson, Detroit 26, Mich.

**American Society of Mechanical Engineers** holds its fall meeting at Hotel Radisson, Minneapolis, Sept. 25-28.

**OCTOBER**

**American Standards Association** will hold its National Standardization Conference in the Waldorf-Astoria, New York, Oct. 22-24. Emphasis will be on standards in national defense. Write ASA, 70 East 45th St., New York, for conference information.

**National Association of Corrosion Engineers** holds the annual meeting of the South Central Region at Corpus Christi, Texas, October 18-20. G. A. Mills, Central Power and Light Co., is general chairman of the meeting.

**The Engineers' Society of Western Pennsylvania** holds its 12th Annual Water Conference at Hotel William Penn, Pittsburgh, Oct. 22-24.

**American Institute of Electrical Engineers** has scheduled the fall general meeting for Cleveland, Oct. 22-26.

**NOVEMBER**

**23rd Exposition of Chemical Industries** will use all available exhibit space on the exposition floors of Grand Central Palace, New York, from Nov. 26 to Dec. 1. Write Publicity Department, 23rd Exposition of Chemical Industries, Grand Central Palace, New York.

750 KVA, THREE PHASE 13,800-2400 with NEMA Std. Access.

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# Readers' guide to advertised products

***This department is both a product index for advertising and a keyed listing for advertised literature. List paragraph key numbers on reader service card to get data you want.***

**See Reader Service Card Page 140**

### AIR & DUST FILTERS & COLLECTORS

**500—See page 64. Electrical Precipitation:** Write for your free Bulletin 500 which presents full information on the Cottrell Precipitator. It effectively cleans stock gases by removing over 95% of all fly ash particles. Research Corporation.

### ANTI-CORROSIVE & PROTECTIVE COATINGS

**501—See page 65. Rust Preventive:** Rust-Oleum seals metal so that no rust-causing oxygen can reach it. Available in a full range of colors. Write for complete literature. Rust-Oleum Corporation.

### BOILERS & BOILER ACCESSORIES

**502—See page 146. Firebox Type Boilers:** Especially adapted for high pressure — 10 to 304 hp, 100, 125, 150 lb wp. Send for full information and free 6 in. scale with pipe diameter markings. Kewanee Boiler Corp.

**503—See page 141. Mechanical Draft Equipment:** Write for further details on Sturtevant Forced Draft Fans, Erosion-Resisting Induced Draft Fans, and power-saving Vane Control that give you dependability and outstanding performance. Westinghouse Electric Corp., Sturtevant Division.

**504—See page 29. Baffles:** Enco streamlined baffles give you 4 major values—better heat transfer; low draft loss; less steam and time for cleaning; custom installation. Write for Bulletin BW44 for full details. The Engineer Company.

**505—See page 166. Draft Inducer:** Mail coupon on page 166 for literature and complete information on the Wing Draft Inducer. L. J. Wing Mfg. Co.

**506—See page 109. Steam Generators:** Mail coupon on page 109 for catalog and desk demonstration of Clayton Forced Recirculation Steam Generators. Clayton Mfg. Co.

### BUILDING HEATING, VENTILATING & AIR CONDITIONING & REFRIGERATION

**507—See page 62. Trane Equipment:** Whatever your factory heating, ventilating, cooling or air conditioning problem is, look first in the answer in the Trane line. An inquiry will bring you complete data on equipment engineered for your particular job without obligation. The Trane Company.

**508—See page 128. Low Temperature Cooler For Food Freezing and Storage:** Write for Bulletin 118 and 119 describing Niagara's "No-Frost Method." Keeps frost and ice completely out of your cooling, chilling, freezing or cold storage. Niagara Blower Company.

### BUILDING MATERIALS & MAINTENANCE

**509—See page 143. Aluminum Jacketing:** Write for complete literature on new low-cost jacketing engineered especially to protect outdoor lines in refineries and chemical plants. Childers Manufacturing Co.

**510—See page 170. Electroforged Steel Grating:** See page 170 which lists 5 built-in advantages found in Blaw-Knox electroforged steel grating. Write for Bulletin 2365. Blaw-Knox Div. of Blaw-Knox Co.

**511—See page 138. Vacuum Cleaning Units:** Write for Spencer Bulletin No. 144, gives complete information on Spencer stationary vacuum cleaning units — handle hot materials, liquids, sand, rice, injurious dusts and gases. Pay for themselves in a few months. Spencer Turbine Company.

**512—See page 164. Vacuum Cleaning Equipment:** Your choice of 4 big-capacity portables. Also, stationary systems in a wide range of sizes to fit your maintenance or production operations. Write today for complete data and recommendations to fit your requirements. U. S. Hoffman Machinery Corporation.

**513—See page 156. Free Repair Handbook:** 40 pages describing Smooth-On repairs that can save you time and money. 170 illustrations. Write for your free copy now. Smooth-On Mfg. Co.

**514—See page 163. Instant-Use Floor Patch:** Tough, plastic material which restores broken concrete to solid smoothness. Run traffic over it immediately. Write for details of free trial offer and "Hand Book of Building Maintenance". Flexrock Co.

### COAL, ASH & BULK HANDLING

**515—See page 131. Bulk Materials Handling Systems:** Stephens-Adamson engineers are at your service to solve your bulk materials handling problems quickly and economically. Write today. Stephens-Adamson Mfg. Co.

**516—See page 147. Hydraulic Ash-Handling System:** Write today for your copy of the new Beaumont brochure: "Answers to Your Ash-Handling Questions". Contains expert recommendations on all types of ash-handling systems. Beaumont Birch Company.

**517—See page 165. Fireless Locomotives:** If you have steam available in your plant, a Porter Davenport-Built Fireless Locomotive can save you up to 50% in haulage and switching costs. Write for complete details. No obligation. Davenport Locomotive Div., Davenport Besler Corporation.

**518—See page 160. Mikro-Atomizer:** With its built-in air separator, the Mikro-Atomizer is a 3-function machine grinding, air-classifying and conveying in one operation. Send for special bulletin. Pulverizing Machinery Company.

**519—See page 142. Electric Vibrators:** If you have a troublesome bin or hopper write the details to Syntron. Their Engineering Department will be glad to give you their recommendations without obligation. Syntron Co.

### COMPRESSORS

**520—See page 61. Compressors:** Write for complete facts concerning Cooper-Bessemer motor-driven JM compressors that offer you big savings. Up to 3000 hp range. The Cooper-Bessemer Corporation.

**521—See page 34. Compressors:** Write for Bulletin 766 describing CP Type Y compressors. Designed for restricted floor space, they provide high efficiency and low maintenance. Sizes from 75 to 250 hp, 501 to 1663 cfm. Write today. Chicago Pneumatic Tool Company.

### CONTROLS, REGULATORS & INSTRUMENTS

**522—See page 163. Temperature Regulators:** Write for Stacon Bulletin 50-1000 for full details on extra sensitive, accurate, economical temperature regulators. See page 163 for checkchart test. Farris Stacon Copr.

**523—See page 110. "Combustion Guide" Instruments:** These bulletins now available at no cost: 30-849 contains data on the Magnotherm $O_2$ Meter, Conductherm $CO_2$ Meter and the Hays Combustion Meter; No. 30-550 gives you full data on Hays-Penn Boiler Efficiency Meter. The Hays Corporation.

**524—See page 161. Jerguson Truscale Gage:** Reproduces your boiler water, deaerating tank, or other liquid level at remote points with accuracy as close as ½ of 1%. Write today for data unit on this exceptional gage. Jerguson Gage & Valve Company.

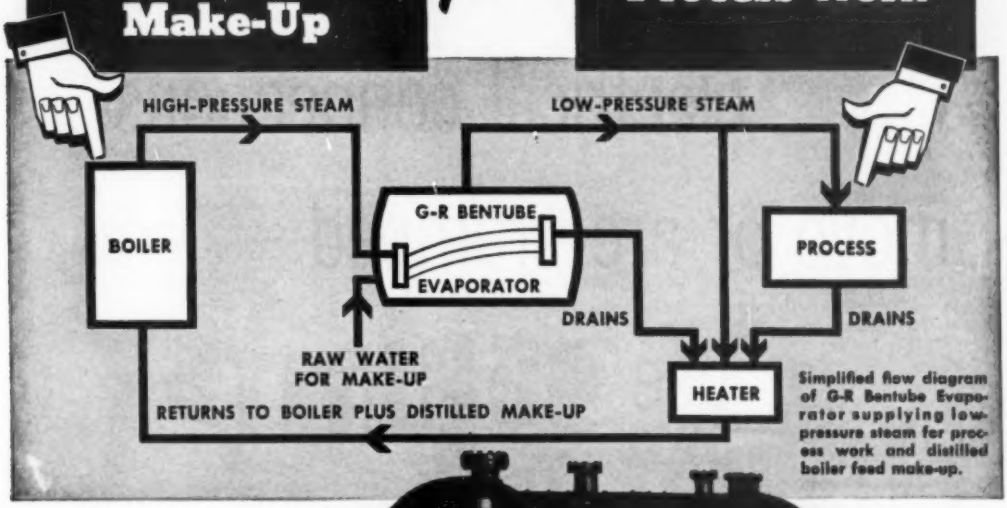
**525—See page 66. Pressure and Temperature Regulators:** Write for Bulletin 350. Spence gives full data on Spence Regulators. They operate at low unit stress for long life, cut down maintenance cost. Spence Engineering Co.

**526—See page 159. RANAREX Indicator and Recorder:** For a quick, dependable check on $CO_2$ content of flue gases, use RANAREX. A sure check that is accurate to within 3/10 of 1% of $CO_2$. Uses no chemicals. Sturdily constructed and easily maintained. Write for free booklet. The Permutit Company.

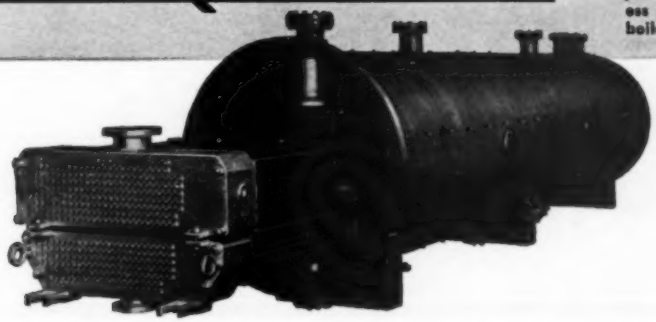
***( Continued on page 138 )***

# with a G-R Bentube Evaporator

**PURE WATER for Boiler Feed Make-Up** *plus* **STEAM for Process Work**




Simplified flow diagram of G-R Bentube Evaporator supplying low-pressure steam for process work and distilled boiler feed make-up.



This two-in-one unit can double as a 100% thermally efficient reducing valve and raw water purifier. Part of the vapor which it produces can be used as low-pressure steam for process work, while the remainder is condensed as distilled water for boiler feed make-up. The G-R "Reducing Valve" Evaporator wastes no heat . . . requires no chemicals.

For more than 50 years, G-R Evaporators have been proving their effectiveness and economy in marine and stationary installations, large and small. Today, they are in use in power generating stations, industrial and process plants all over the country, as well as on many hundreds of naval and merchant marine vessels . . . wherever pure water is a necessity.

The exclusive features and distinctive advantages of G-R Bentube Evaporators include their famous scale-shedding Bentube elements, design provisions for pure vapor, thorough drainage and easy accessibility.

*Write for Bulletin describing these units in detail.*

**THE GRISCOM-RUSSELL CO., MASSILLON, OHIO**

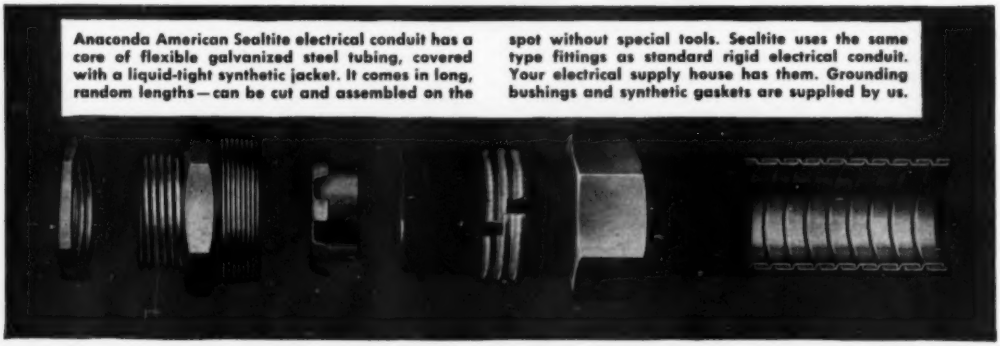
GR-363

**GRISCOM-RUSSELL**

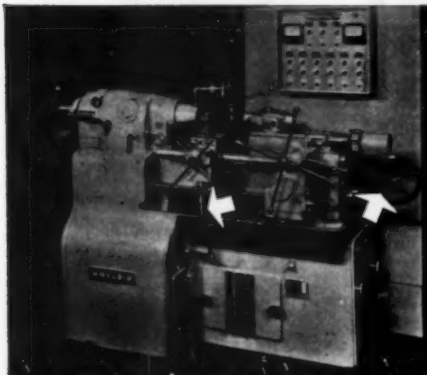
PIONEERS IN HEAT TRANSFER APPARATUS

# Wherever electrical connections move or are cramped – use SEALTITE

## Anaconda's flexible Liquid-Tight Conduit


Anaconda American Sealtite electrical conduit has a core of flexible galvanized steel tubing, covered with a liquid-tight synthetic jacket. It comes in long, random lengths—can be cut and assembled on the spot without special tools. Sealtite uses the same type fittings as standard rigid electrical conduit. Your electrical supply house has them. Grounding bushings and synthetic gaskets are supplied by us.

for **flexible, liquid-tight** electrical conduit...specify

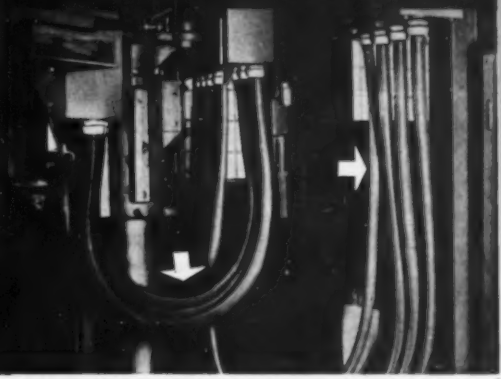


**Control wiring on machines.** Sealtite is the ideal conduit for machine tools, motors, short radii bends and wherever wiring must be protected against water, oil, grease, chemicals or abrasives.

**For minimizing vibration** between switch-control box and ventilating fan on rooftop. Sealtite is equally at home on inside installations and outside uses, such as this.

**Complete protection** is supplied by Sealtite for wiring between rigid conduit and trip switch operating conveyor of this beer case gluing machine.

**Movable-head junction box connection** to stationary junction box on boiler welding jig. Flexibility permits timesaving installation. Sturdy construction of Sealtite assures full protection, avoids expensive rewiring.



**Upper Left:** *Photo Courtesy: The Monarch Machine Tool Co., Sidney, Ohio.*
**Lower Left:** *Photo Courtesy: The Kooley Brewing Co., Chicago, Ill.*

**Upper Right:** *Photo Courtesy: Pacific Gas & Electric Co., San Francisco, Calif.*
**Lower Right:** *Photo Courtesy: Kewanee Boiler Corp., Kewanee, Ill.*

Sealtite*, the completely flexible, liquid-tight conduit simplifies all types of electrical connections involving motion or vibration—especially to motors and portable equipment. Its flexibility dampens vibration, makes short radii bends.

Sealtite's synthetic jacket can resist oil, water, most chemicals, steam and abrasion. Its tough steel core stands up under impact.

Your electrical supply house carries Sealtite. If you would like more information, send in the coupon today.

*Trademark

61220

# SEALTITE

## AN ANACONDA PRODUCT

For complete information on Sealtite Conduit, write for Bulletin C-188 to The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut In Canada: The Canadian Fairbanks-Morse Company, Ltd.

NAME _____

COMPANY _____ (If more than)

STREET _____

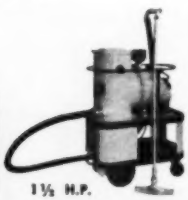
CITY _____ ZONE _____ STATE _____

# WHY GOOD *Plant Sanitation* COSTS LESS WITH SPENCER VACUUM

It is a fact that large or congested industrial areas can be Spencer Vacuum cleaned better and faster, at less cost, than by hand or with inadequate power. And with Spencer, the dirt container has ample capacity and is easily removed and rolled on casters to the point of disposal. In addition, special Spencer Vacuum tools take care of overhead pipes, walls, machinery and even the boiler tubes and hot materials which can be removed before they cool off.

AN EXTRA DIVIDEND. But the big saving comes when you apply Spencer Vacuum to the production line. For instance, you can recover valuable metal chips by the ton, convey loose materials by the carload, remove welding and other toxic fumes at their source and speed up bench and assembly work in every department.

There are at least 132 Essential and Unusual Uses for Spencer Vacuum in Industry—all described in Bulletin No. 144—yours for the asking.


1½ H.P.

7½ H.P.

427-D

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

SPENCER
HARTFORD


## Readers' guide to advertised products

*( Continued from page 134 )*

**527—See page 147. Boiler Feed Regulators:** Write for complete details on the Henszey line of boiler water level controls, made for pressures up to 600 lbs and in sizes up to 4 in. Henszey Co.

**528—See page 46. Electronic Analyzer:** Weston Model 769 ultra high frequency electronic analyzer provides greater economy and convenience for practically all electronic measurements. A three-in-one instrument suited for AM, FM, television testing, and many applications in HF and VHF fields. Write for literature. Weston Electrical Instrument Corporation.

**529—See page 113. Measuring Devices:** You can obtain complete information in brochures describing force measuring devices, push pull gauges, traction dynamometers and laboratory scales by checking the brochure you need on the special coupon to be found on page 113. John Chatillon & Sons.

**530—See page 60. Temperature Regulators:** Write for free Catalog No. 605. Lists 12 different styles of temperature regulators for heating, cooling and air conditioning; temperatures 0-300° F; valve sizes 3/8" to 8". Sarco Company, Inc.

**531—See page 157. Regulators and Thermometers:** Bulletins 500 and 1000 give you full data on regulators and thermometers that will cut your processing cost to a new low. H. O. Trerice Co.

**532—See page 163. Automatic Liquid Measuring Gages:** Write for complete details on liquid level gages for measuring liquids of all kinds. Dial readings in feet, inches, gallons, pounds or any desired units. The Liquidometer Corp.

**533—See page 132. Accritem Regulators:** Write for Bulletin 316 for prices and further information on Powers Accritem regulators and diaphragm valves. Gives accurate, low cost heat control for liquids or air. The Powers Regulator Co.

**616—See page 146. Temperature Recorders:** Precision-built for your specific needs. Low-cost protection. Send for catalog showing Auto-Lite Temperature Recorders and Indicators. The Electric Auto-Lite Company.

### CRANES, HOISTS AND CAR PULLERS

**534—See page 167. Silent Hoist Electric-Driven Car Puller:** Only one man and this car puller can pull and spot cars — warp barges — drop pallet or skid loads — bend pipe — open hopper doors — and cut your bulk handling costs. Get full information today by writing for Bulletin No. 64A. Silent Hoist & Crane Co.

### DIESELS

**535—See page 58. 4-Cycle Supercharged Diesels:** Ask for details and proof that these engines will supply more kilowatt hours per gallon of fuel oil. Write today. Worthington Pump and Machinery Corporation, Engine Division.

### ELECTRICAL DISTRIBUTION

**536. See page 32. Magnetic Starters:** Write for free illustrated booklet complete with design and operating features, dimensions, ratings, catalog and parts numbers, covering the complete line of "RA" magnetic starters. Sizes 0-1-2-3-4. The Arrow-Hart & Hegeman Electric Co.

**537—See pages 18, 19. Mechanical Rectifiers:** Write for I-T-E Bulletin 5106 that contains complete technical data on I-T-E Mechanical Rectifiers with detailed presentation of operating principles. Available in ratings from 4,000 to 10,000 amps. I-T-E Circuit Breaker Company.

**538—See page 59. Renewable Fuses:** You are invited to write for latest catalog for more information about "Economy De-Lay" Renewable Fuses, which give safe protection where most overloads occur — in the 135 to 200% range. Economy Fuse and Mfg. Co.

**539—See page 170. Fuses and Clamps:** Send for free Booklet 206-A that shows you the many advantages possible with the Powder-Packed custom-built element in Trico Fuse. Also request Bulletin No. 7 for more details on "Kliplok" Test Clamps for heavy duty temporary connections, meter and motor testing, jumpers, welding, etc. Trico Fuse Mfg. Co.

**540—See pages 40, 41. Fusetrons:** A fuse to which is added a thermal cutout offers large time-lag and less electrical resistance. Fits standard fuse blocks and may be used throughout entire electric system. Send coupon for complete facts about Fusetron Dual-Element Fuses. Bussmann Mfg. Co.

### FILTERS, STRAINERS & PURIFIERS

**541—See page 54. Self-Cleaning Strainers:** Write for Bulletin 465 on Leslie self-cleaning strainers. Sizes from ¼" to 10" in cast iron, cast bronze, cast steel, carbon moly, chrome moly, and stainless steel, with screwed, flanged or socket welding connections for pressures to 1500 lbs., temperatures to 1000° F. Leslie Co.

**542—See pages 136, 137. Sealtite Flexible Conduit:** The ideal flexible electrical conduit for wiring on machines, motors, controls, etc.; for protecting wiring against water, oil, grease chemicals or abrasion. Send coupon on page 137 for Bulletin C-188. American Metal Hose Branch, The American Brass Company.

### FUELS & FIRING EQUIPMENT

**543—See page 23. Coal:** If you have a coal problem, consult the Beacon Combustion Service Man for the type to fit your exact needs from the Beacon line of quality fuels. Eastern Gas and Fuel Associates.

**544—See page 17. Fanmix Gas and Oil Burners:** Use coupon in this advertisement to get complete data on Coppus-Dennis Fanmix burners that allow you to get more heat release per cu. ft. of furnace volume. Coppus Engineering Corp.

**545—See page 56. Bell & Zoller Coals:** Four more mines have been acquired to raise coal producing capacity to the highest level in history and enables Bell & Zoller to offer you an even more diversified selection of top-quality brand coals. Write for full information on qualities of famous brands now offered by Bell & Zoller Coal Company.

*( Continued on page 142 )*


THE spring IS THE THING!

KNIFE-EDGES *BITE* INTO FLANGE SURFACES

AJAX

SPIRAL WOUND GASKETS

The gaskets with more "bounce to the ounce" of bolt load. Built-in resilience for positive permanent seals.

Made for all types of pipe flanges, pressure vessels, boiler manholes, handholes, tube caps, water walls, economizers and other boiler accessories. Ask your supply house. AJAX gaskets, are universally available through Industrial Distributors.

PRESSURE-SEALED

THEY BREATHE WITH VARYING PRESSURES AND TEMPERATURES

HEAT EXCHANGER GASKETS

Double jacketed metal-asbestos, precision made to specifications in any desired size, shape or metal. Estimates furnished on receipt of details. Write

LIGHTER BOLT LOADS. SAFER SEALS

NO DRIP—NO SQUIRT—NO HISS

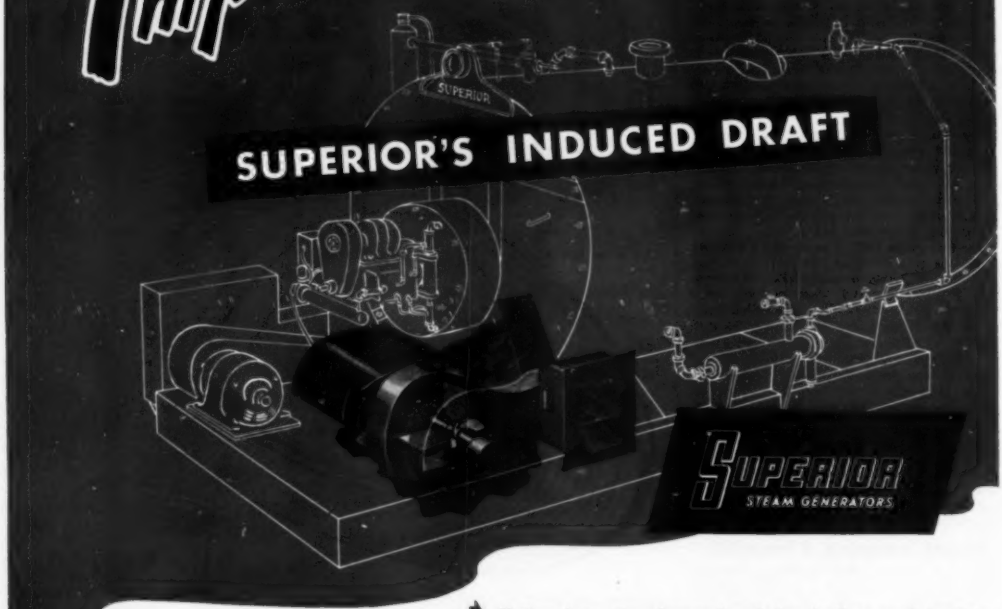
UNITED STATES GASKET COMPANY

670 N. 10th Street Camden 1, N. J.

*Leading Fabricators of "TEFLON" for the Chemical, Process and Electronic Industries.*

# Improving a Proven Principle

## SUPERIOR'S INDUCED DRAFT




Built to operate on the same proven principle as natural draft, Superior's *Induced Draft*, because of its built-in design, low-speed fans, and unique construction, assures maximum boiler capacity at high efficiency. It provides accurate control of draft conditions without the usual disadvantages of mechanical draft. Cleaner, quieter, and safer in every respect, it represents but one of the many "Designed by Demand" features which contribute to the overall efficiency and long life of Superior Steam Generators.

Superior Steam Generators are shipped completely assembled, backed by undivided responsibility • Burn gas or oil, or both • 18 sizes from 20 to 600 b.h.p. for pressures up to 250 p.s.i. or for hot water • Write today for Catalog 302.

1. Tailored to the demands of the boiler, and built-in, Superior's *Induced Draft* regulates the air necessary for efficient combustion. Leaves front platform clear.
2. Full-width fan construction minimizes the danger of overworked or burnt-out tubes by providing an even draw across the entire tube area of the boiler.
3. *Induced Draft* eliminates the danger of forcing the products of combustion into the boiler room to spread dust, dirt, and unhealthful air throughout the building.
4. Especially-designed over-size fans run slower, minimizing wear and maintenance.
5. Quieter, low-speed fans eliminate the high-pitched whine commonly associated with forced mechanical draft.
6. Long-lived trouble-free operation assured by corrosion-resistant fans with outboard mounted bearings located out of the path of combustion gases.
7. Eliminates the expense of a large chimney.

uperior ombustion ndustries, inc.

*Factory:* Emmaus, Pa.
*Executive Offices:* Times Tower, Times Square, New York 18, N. Y.

PUTTING *Air* TO WORK FOR JEFFREY MANUFACTURING

The Sturtevant E-R wheel resists abrasion.

# *No Maintenance* IN *19* MONTHS

**. . . A report from The Jeffrey Manufacturing Company**

This report is familiar to the many satisfied users of Sturtevant Turbovane® Induced Draft (T.V.I.D.) Fans equipped with performance-proven E-R (Erosion Resistant) Wheels.

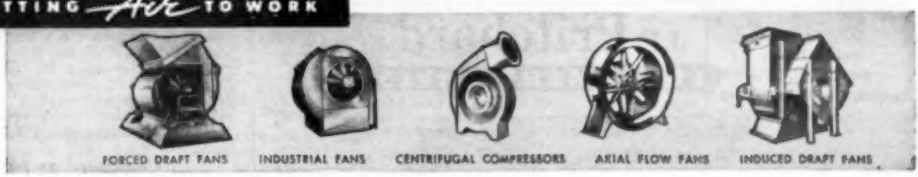
The Jeffrey Manufacturing Company selected *dependable* Sturtevant T.V.I.D. Fans for each of three pulverized coal-fired boilers in their modern new boiler plant at Columbus, Ohio. The decision to use E-R wheels was based on the fact that gases reaching these fans would contain abrasive fly ash. This decision is paying off in lowered maintenance and greater dependability for The Jeffrey Manufacturing Company, just as it has paid off for many other industrial power plants and major utilities throughout the country.

Westinghouse-Sturtevant Forced and Induced Draft Fans, with optional Vane Control® for part-load operation, are available in a wide variety of sizes and types; also, other air handling and electronic air cleaning apparatus. Put us to work *putting air to work* for you. Call your local Westinghouse-Sturtevant Office or write Westinghouse Electric Corp., Sturtevant Division, Hyde Park, Boston 36, Massachusetts.

**YOU CAN BE SURE...IF IT'S Westinghouse**

PUTTING *Air* TO WORK

J-80230



Of course.... Another Syntron Electric Vibrator

This V-25 Electric Vibrator on hopper supplying bucket elevator keeps material flowing freely, without surges, and without periods of coming "short".

SYNTRON

"Pulsating Magnet"

# ELECTRIC VIBRATORS

**With Variable Control of Power**

3600 controllable vibrations per minute keep even the most stubborn materials flowing freely thru bins, hoppers, chutes and screens . . . WITHOUT THE HAMMERING AND RODDING AND POKING THAT WASTES MANPOWER AND DAMAGES EQUIPMENT.

For 1 cu. ft. hoppers up to large storage bunkers.

**Write To—**

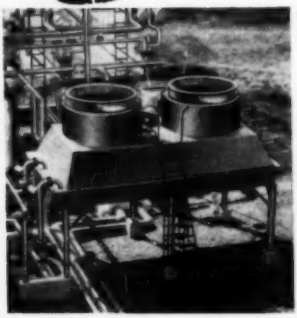
**SYNTRON COMPANY**

425 Lexington Avenue — Homer City — Penna.

**Only Thorough Engineering and Adequate Sizing Can Give You Pritchard Quality!**

**New Pritchard Type "B" QUINTAIR***

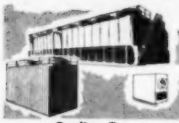
**Air Cooled Heat Exchanger**



Pritchard *quality* means a lot when it comes to selecting air cooled heat exchangers. Take Pritchard's Type "B" QUINTAIR* for example. All parts requiring attention are readily accessible and easily serviced. Thoroughly engineered for long life and operating economy—adequately sized for top performance under the most exacting conditions—the Pritchard Type "B" QUINTAIR* can handle one or several different heat loads in a single compact unit. Whatever your cooling problem, it will pay you to investigate the Pritchard Type "B" Air Cooled Heat Exchangers.

*Write today for full information.*

*Registered Trade Name



Cooling Towers
Gas & Air Treating
Specialized Heat Exchangers

Producers of QUALITY Specialized Process EQUIPMENT

**J.F. Pritchard & Co.**

**EQUIPMENT DIVISION**

Dept. No. 164 — 908 Grand Ave., Kansas City 6, Mo.

District Offices: CHICAGO • HOUSTON • NEW YORK • PITTSBURGH
TULSA • ST. LOUIS • Representatives in Principal Cities from Coast to Coast


## Readers' guide to advertised products

*( Continued from page 139 )*

**546—See page 107. Perfect Spread Stoker:** Capacity range from 8,000 to 500,000 steam per hour — coal feeders are adjustable from 50 lbs to 7500 lbs of coal per hour. Mail coupon on page 107 today for a copy of the Perfect Spread Stoker booklet and for a reprint of a new report on large spreader stokers. American Engineering Company.

**547—See page 167. Fuel Oil Additive:** Houghto-solv is Houghton's proven additive for treatment of fuel oil systems to remove sludge by taking it into solution and actually making it burnable. Mail coupon on page 167 for sample test and full information. E. F. Houghton & Co.

### HEAT EXCHANGER EQUIPMENT

**548—See page 142. Quintair Heat Exchanger:** Pritchard Type "B" Quintair air cooled heat exchanger can handle one or several different heat loads in a single compact unit. Write for full information. J. F. Pritchard & Co.

**549—See page 24. Refrigeration Condensers:** Free Bulletin RC-1 gives you complete details on horizontal and vertical types shell and tube condensers for every service. Be sure to write today. Henry Vogt Machine Company.

### LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

**550—See page 152. Non-Fluid Oil:** Send for Bulletin No. 506 and free testing sample of Non-Fluid Oil for positive bearing protection. New York & New Jersey Lubricant Company.

**551—See page 121. Colloidal Graphite:** A specially prepared article entitled "Forging Die Lubrication" explains the uses of **"dag"** colloidal graphite for hot forging operations. Write for Bulletin No. 750-17J. No obligation. Acheson Colloids Corporation.

**552—See page 53. Lower Lubrication Costs:** Refer to coupon on page 53 to request a "Desk-Top Demonstration" of Oil-Mist. This entails no cost or obligation on your part. There is also space to check for additional information about Oil-Mist by mail. Alemite, Division of Stewart-Warner.

**553—See pages 35, 36. Lubrication Service:** Consult your nearest Standard Service-Supply Center for your lubrication needs. Deliveries can be made in a few hours. Also ask about Stanoil for clean, maximum performance in hydraulic units, speed reducers and circulating systems — expert, personal service by Standard Oil lubrication specialists, too. Write for full information. Standard Oil Company (Indiana).

### MATERIALS OF CONSTRUCTION

**554—See page 44. "K" Monel:** Write for Technical Bulletin, T-9, "The Engineering Properties of 'K' Monel". Contains data on composition, mechanical properties and physical constants of heat-treatable, non-magnetic "K" Monel. The International Nickel Company, Inc.

*( Continued on page 144 )*

This close-up clearly shows the ribs or corrugations which add strength to Childers Jacketing and also make it form more easily around lines. Aluminum strapping and seals are a quick, inexpensive way to attach the jacketing. They can be used without any special tools and take no special training for the installers.

Does long lasting aluminum cost too much for covering your insulated lines? Not when you specify this new type weatherproof jacketing. It has been specially developed to cost little more than ordinary temporary jacketing materials.

# New Low-Cost Jacketing Cuts Maintenance on Insulated Lines

AT LAST an aluminum jacket has been "engineered" especially to protect outdoor lines in refineries and chemical plants. It is the first "permanent-type" jacketing that offers both low initial cost and low application cost.

After two years of tests and major installations at 431 outdoor locations in power plants, refineries, and chemical plants, the Childers Manufacturing Co. of Houston has rung up an impressive cost-cutting record with their Childers Aluminum Jacketing.

Secret behind this low cost is the thin aluminum sheet—.006" thick—which is the weather-protecting sheath of the jacketing. It is ribbed (as pictures show) for extra strength and to facilitate forming around the line. This aluminum has proved thick enough to resist weathering and usual abrasion, but costs much less than heavier aluminum sheets.

Easy application of this Childers Jacketing cuts labor bills drastically. It comes from the factory in easy-to-handle rolls that are four feet wide and either 100 feet or 200 feet long. It is light and flexible to handle as the men put it on the line. No roll forming required as with heavy, un-crimped material. It can be cut off and attached just the same as the old-fashioned tar-paper that was sometimes used for jacketing.

You can attach Childers Jacketing around your insulated lines by one of several easy methods. The use of aluminum strapping and seals is probably the best. Sheet metal screws or Minnesota Mining's No. 471 tape can also be used.

The Childers jacketing can be removed and re-used.

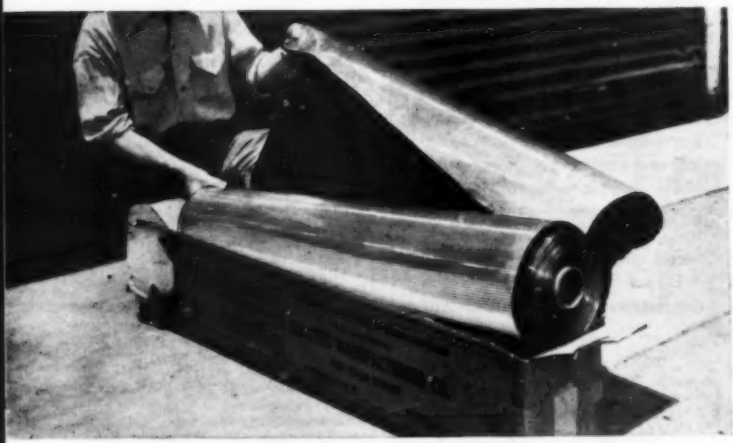
A moisture barrier is attached to the back of the jacketing to give positive protection for the aluminum when it is used with alkaline insulating materials.

No painting, no rust-proofing, little maintenance — that's the advantage of aluminum!

Hundreds of design engineers and maintenance engineers have agreed they save money for their firms and trouble for themselves by changing their jacketing specs to Childers 100%. That should make it worth your testing too—and a test roll costs only $40.00 for 400 sq. ft. (with moisture barrier attached—price for 800 sq. ft. without moisture barrier $62.00). That's a good investment in any plant. (Advt.)

* * *

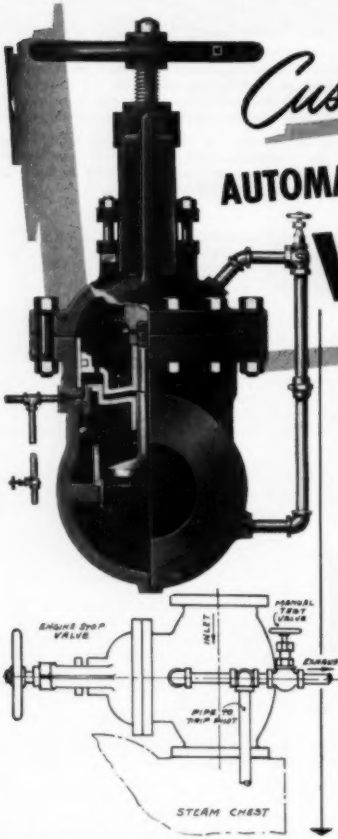
FOR FULL INFORMATION write Childers Manufacturing Co., Dept. YP-2 625 Yale St., Houston 7, Tex., for complete literature. Childers has engineering representatives in principal cities to work with you on specific problems.



This is how Childers Aluminum Jacketing is shipped in easy-to-handle rolls. It is quite flexible, yet stands up under severe weathering.

WHEN ENGINES, TURBINES OR COMPRESSORS *OVERSPEED*

*Shutdown is Automatic* with GA *Cushioned* AUTOMATIC ENGINE STOP VALVES




**Mechanically or Electrically Tripped**

A single speed governor trips a pilot control valve, which automatically closes this valve against inflow pressure—thus assuring complete protection from damage caused by overspeeding.

All Golden-Anderson Valves have a special double cushioning feature which prevents banging and chatter.

Get the life and property protection you need—specify and install Golden-Anderson cushioned engine stop valves today!

Do you have Bulletin S-3 which describes this valve in detail?

GOLDEN ANDERSON *Valve Specialty Company*

2095 KEENAN BUILDING • PITTSBURGH 22, PA.


## Readers' guide to advertised products

*( Continued from page 142 )*

### MECHANICAL POWER TRANSMISSION

**555—See pages 14, 15. Gear-Type Couplings:** Send coupon on pages 14, 15 for further information regarding Amerigear couplings with fully crowned teeth and Catalog No. 501. American Flexible Coupling Co.

**556—See pages 30, 31. Dayton Cog-Belts:** Put cost-cutting teeth in your V-belt drives. Dayton Cog-Belts mean 40% more horsepower per belt, fewer pulley grooves, fewer belts, and longer belt life. Complete data and cost information upon request. Dayton Rubber Company.

**557—See pages 49, 50, 51, 52. B. F. Goodrich Grommet Belts:** These V-Belts, because of an entirely different construction principle, stand more shocks and heavier loads than any other kind—last 20 to 50 per cent longer, depending on service—have more rubber, are more flexible, and give better grip. Read pages 49, 50, 51 and 52 for interesting data about the money-saving Grommet V-belts and write for complete data and prices. Industrial Products Division, The B. F. Goodrich Company.

**558—See page 126. Gear Type Couplings:** For trouble-free coupling service write for full catalog on Waldron gear type couplings. Solid cover sleeve, non-welded — no metal-to-metal wear —hermetically sealed. John Waldron Corporation.

**559—See page 3. V-Belts:** When you buy V-belts, be sure to specify Gates Vulco Rope — gives you the money-saving "concave side" feature. Write for details. The Gates Rubber Co.

**560—See page 123. Multi-V-Drives:** Send coupon on page 123 for Bulletin No. V-1400-B7F for full details on Worthington Multi-V-Drives and QD Sheaves. Worthington Pump and Machinery Corporation.

### PACKAGED STEAM GENERATORS

**561—See page 57. Cleaver-Brooks Steam Boiler:** Available in sizes 15 to 500 hp, 15 to 200 lb psi. Write for your copy of the Cleaver-Brooks steam boiler catalog — interesting, informative, beautifully illustrated. No obligation. Cleaver-Brooks Company.

**562—See page 63. Keystone Generator:** 2-drum water tube boiler, automatic oil and gas burner, induced draft fan, operating and safety controls. Easily cleaned — nationally serviced. Write for Bulletin SB-38. Erie City Iron Works.

**563—See page 148. Speedylectric Boiler:** Write for illustrated literature on the Speedylectric Boiler that gives you steam hot, dry and when you want it. Process temperatures up to 565° F. Also ask for Bulletin 74B describing Speedylectric Steam-Jet Cleaner. Livingstone Engineering Co.

**564—See page 140. Packaged Steam Generators:** New, fully illustrated Cata-

*( Continued on page 146 )*

# CONCENTROL STOPS FOAMING

**BEFORE**

Laboratory demonstration shows foaming of highly alkaline solution in test cylinder.

This laboratory demonstration shows — as do scores of successful installations — that Bird-Archer's Concentrol is a highly effective anti-foam agent. It quickly stabilizes alkaline boiler water . . . eliminates foaming action and carryover. With Concentrol, you can forget about bouncing water gages. You get good quality dry steam every hour of every day.

Concentrol is available in liquid, powdered or briquette forms. Special Concentrol formulations are also available containing other commonly used boiler water treatment chemicals such as tannins, phosphates, alkalies, sulfite, etc.

See for yourself how economical Concentrol helps improve steam quality. Your Bird-Archer representative will demonstrate Concentrol in your plant . . . make specific recommendations for its use. Consult him, or write direct to Bird-Archer, outlining the details of your boiler operation.

***FREE DATA SHEET AVAILABLE***

**HOW CONCENTROL WORKS**

Concentrol works by effecting a rapid change in surface tension of steam bubbles which permit coalescence of small steam bubbles into bubbles of larger sizes. This results in the formation of unstable bubble films which break readily upon reaching the steam disengaging surface of the boiler water. This does away with foam build-up and subsequent carryover.

**AFTER**

Some solution after addition of 12 ppm of Concentrol Anti-foam. Constant heat conditions were maintained during test.

**BIRD · ARCHER**

**WATER TREATMENT**

**THE BIRD-ARCHER COMPANY**

**4337 North American St., Philadelphia 40, Pa.**

**NEW YORK · CHICAGO**

**IN CANADA**

The Bird-Archer Co., Limited

503 McGill Building, Montreal, Canada

**IN MEXICO**

Calderos y Accesorios, S. A.

Amsterdam 291, Mexico D. F.

BA 162

Depend on

AUTO-LITE

FOR TEMPERATURE INDICATION

Auto-Lite Thermometers are designed to give you the broadest selection for your needs. Priced low and precision-made for accuracy, these instruments point the way to temperature savings and help to prevent spoilage. Write for catalog showing the many styles and types of Auto-Lite Thermometers that are available.

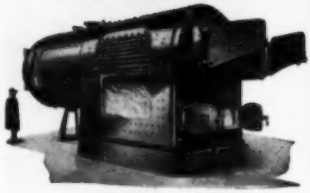
TYPICAL APPLICATIONS: STORAGE TANKS & ROOMS, COOLERS, DRYERS, AIR CONDITIONING, PILOT PLANTS.

*Illustrated, at top: Model G Indicating Thermometer, flush mounting type with capillary tubing for remote reading. Priced from $18. At bottom: Model V Thermometer (vapor pressure type). Rigid stem for direct mounting. Priced from $10.25.*

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION, DEPT. M-8
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

INDICATING & RECORDING THERMOMETERS

KEWANEE
HEAVY-DUTY



10 to 304 hp
100, 125 and 150 lbs wp

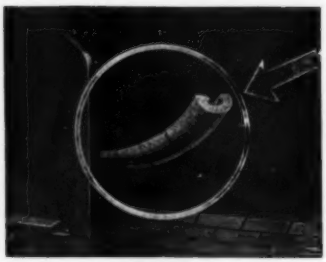
Has all the characteristics which make firebox boilers ideal for high pressure. Complies fully with ASME and SBI codes.

Outstanding for extra years of dependable service in producing hi-pressure steam economically with Oil, Gas or Coal.

*WRITE Department 96-D9* 949
*for 6" scale with pipe diameter markings*

KEWANEE BOILER CORPORATION
KEWANEE, ILLINOIS

What if the seam let go?



After the lapped edge at the circumferential seam of an HRT boiler has burned off close to the rivets, there is danger of the seam opening up under pressure. The consequences might be serious.

National Seam Protectors prevent fire-cracking and oxidation of boiler plates at seams. Owners of riveted HRT boilers have found National seam protection practical and profitable during the past 34 years.

You should get all the facts. Write us now while you're thinking of it.

NATIONAL BOILER PROTECTOR CO.
928-9 Rybold Bldg., Dayton 2, Ohio


## Readers' guide to advertised products

*( Continued from page 144 )*

log 302 gives complete details for units available in 18 sizes. Write today. Superior Combustion Industries, Inc.

**565—See page 109. Forced Recirculation Steam Generators:** See page 109 for outstanding features of this Clayton self-contained steam plant. Use the coupon to request a desk demonstration of Clayton Forced Recirculation principle and/or catalog. Clayton Manufacturing Company.

**566—See page 149. Amesteam Generator:** Dependable, quick steaming unit. Minimum installation expense, economical operation. Write for latest free bulletin. Ames Iron Works.

**567—See page 127. Steam-Pak Generator:** Steam-Pak Generators are built in capacities from 15 hp up, for low or high pressure, steam or hot water, for light or heavy oil, combination gas and oil, or straight gas. Write for complete data. York-Shipley, Inc.

**568—See page 25. Powermaster Steam Generator:** Write for Catalog 1218 that gives you the entire story of the Powermaster steam generator. 15 to 500 hp; high or low pressure models for steam or hot water. Orr & Sembower, Inc.

### PACKING & GASKETS

**569—See page 139. Ajax Spiral Wound Gaskets:** Made with built-in resilience to make positive, lasting seals. Also write for data on complete line of corrugated metal and metal-asbestos gaskets; solid metal, serrated and profile types. Write today. United States Gasket Company.

**570—See page 124. Packings:** Investigate Braided's pliable, non-scoring, non-hardening service — and the complete line of Palmetto Self-Lubricating Packings. Write for Bulletin LP-10. Greene, Tweed & Co.

**571—See page 38. High Pressure Packings:** Whatever your packing, gasket, or sheet requirements, consult your R/M Catalog and call your authorized R/M packing distributor. Write for copy today. Raybestos-Manhattan, Inc., Packing Division.

### PIPE AND FITTINGS

**572—See page 150. Twin-Weld Hose:** Twin-Weld is only one of many Hewitt-Robins "firsts" that have made the handling of fluid and solid bulk materials faster, more dependable, efficient, and economical. Write for details. Hewitt-Robins, Inc.

**573—See page 156. Flexible Metallic Hose:** "Atlantic" metal hose survives most extreme conditions. Seamless or interlocking, in bronze, steel, stainless steel, monel. Write for Catalog 500. Atlantic Metal Hose Co., Inc.

**574—See page 153. Revolving Joints:** Send for Bulletin No. 300 for complete story on Barco Revolving Joints for handling steam, water, air, oil and gas. Barco Manufacturing Co.

### PUMPS

**575—See page 172. Warren Pumps:** Write for Bulletin 244 with complete

details on why Warren six stage, Type TH high pressure boiler feed pumps are a most dependable investment. Warren Steam Pump Co.

**576—See page 148. Viking Rotary Pumps:** Write for your free copy of Viking Service Manual G. A handy, illustrated booklet giving you practical help in mounting, operating and maintaining Viking Pumps. Viking Pump Company.

**577—See page 45. Boiler Feed Pumps:** Whatever your boiler-feed application, there's an Ingersoll-Rand pump that's right for the job. Your nearest I&R representative will be glad to give you complete information. Ingersoll-Rand.

**578—See page 120. Hydropress Pumps:** Write for more information on BJ Hydropress Pumps that descale forged parts hydraulically in 1½ seconds. Byron Jackson Co.

**579—See page 116. Weinman Pumps:** They work at maximum efficiency on every job. If your plant handles liquids in any form, it will pay you to consult a Weinman centrifugal specialist. Write today for complete data. The Weinman Pump Company.

### REFRACTORIES

**580—See page 158. Refractory Cement:** Write for full details describing this Super 3000 Refractory Cement that protects inside insulation of metal ducts, flues and breechings with maximum efficiency. Refractory & Insulation Corp.

**581—See page 146. Boiler Seam Protector:** Free bulletin describes this protector that stops warpage and oxidation of lapped edges; averts leaking, calking, patching. Write today. National Boiler Protector Co.

**582—See page 7. Refractory Products:** Write for full details on B&W firebrick, castables, mortars, plastics, insulating firebrick. Let Babcock & Wilcox solve your refractory problems. Babcock & Wilcox Co., Refractories Division.

### SOOT BLOWERS & TUBE CLEANERS

**583—See page 149. Fast-Acting Wilson Tube Cleaner:** See page 149 for the important advantages of this improved Model TP-301 Tube Cleaner. Send today for details, giving your specific requirements. Thomas C. Wilson, Inc.

### STEAM SPECIALTIES

**584—See page 122. Traps:** Heavily constructed, B&J medium and high pressure traps are designed for steam pressures between 15 and 100 lbs gage. Write for complete information. Barnes & Jones, Inc.

**585—See page 171. Steam Traps:** Write for Catalog 751 with full details on Nicholson W. O. Traps that stop costly loss of steam and air. Three types — for pressures to 1500 lbs. W. H. Nicholson & Co.

**586—See page 2. Steam Trap Handbook:** The 36-page steam trap book gives Armstrong trap capacities and tells how to select the right size trap for every job. Write for copy. Armstrong Machine Works.

**587—See page 68. Impulse Steam Traps:** To get equipment hot and into production faster, use Yarway impulse steam traps. Write for full information on how these traps keep equipment continuously at peak operating temperatures. Yarnall-Waring Company.

*( Continued on page 148 )*


**HENSZEY *Boiler Feed* REGULATOR**

***Keeps a* WATCHFUL EYE *on* BOILER WATER LEVELS**

**• CONTINUOUSLY • AUTOMATICALLY • ACCURATELY *under* ALL LOAD CONDITIONS**

They help avoid the hazards of high, as well as low, water levels. They function night and day—once installed and set for operator no attention is necessary—nothing to get out of order—nothing to rust.

A simple, compact unit—installs right in the line—no additional supports are necessary. Pressures up to 600 lbs., sizes up to 4 in. For details consult Sweet's Catalog or write:

**HENSZEY COMPANY**
**DEPT. A9, WATERTOWN, WISCONSIN**

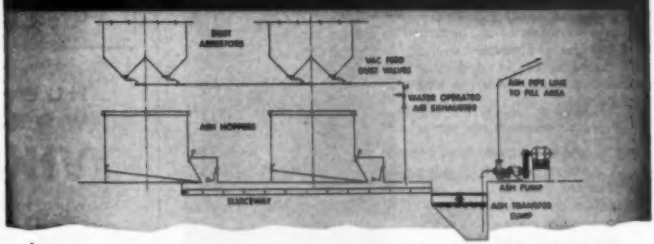
**HENSZEY**

**BOILER FEED REGULATORS**

**Continuous Blowdown • Distillation Systems • Heat Exchangers**
**Feed Water Meters • Flow Indicators • Proportioning Valves**
**also MILK EVAPORATORS and PRE-HEATERS**

*Need Large Capacity Ash-Handling?*

**CHECK WITH BEAUMONT ON A HYDRAULIC ASH-HANDLING SYSTEM**




A Beaumont HYDRAULIC System is particularly suited for high capacity ash-handling; handles wet ash or dry, molten slag and large clinkers; fits any type of power plant arrangement; is completely enclosed, preventing dust or gas from escaping to the boiler room; and can be operated by one man on a part time basis.

Beaumont's Ash-Handling Division is competently staffed to give you expert recommendations on all types of ash-handling systems . . . and to provide and install the proper equipment to suit your particular requirements. Write today for the Beaumont brochure: "Answers to Your Ash-Handling Questions".

**Beaumont BIRCH COMPANY**
**1509 RACE STREET, PHILADELPHIA 2, PA.**

DESIGNERS—MANUFACTURERS—ERECTORS BULK-MATERIAL HANDLING SYSTEMS

## Readers' guide to advertised products

*( Continued from page 147 )*

**588—See page 20. Steam Traps:** Unique Duo-Step design doubles drainage capacity to give you double value—lets you use smaller, less expensive traps to do larger drainage jobs. Send for complete information. The Clark Manufacturing Company.

**589—See page 115. Insulating Cement:** Send for complete information on B-H rockwool insulating cement. Write today. Baldwin-Hill Company.

### TOOLS

**590—See page 22. Airetool Bulletins:** Write for free Bulletins Nos. 40, 44, and 47 with complete description of Airetool handy tools that will reduce your down-time and increase your profits. The Airetool Mfg. Co.

**591—See page 155. Toledo Pipe Tools:** Complete Toledo line includes Hand Tools, all pipe sizes, ⅛" to 12" and ¼" to 1" bolts. Power pipe machines up to 2" and 4" capacity. Write for catalog. The Toledo Pipe Threading Machine Co.

**592—See page 6. Proto Tools:** Send 10¢ today for the new 68-page catalog of PROTO Tools. Plomb Tool Company.

**593—See page 163. Combination Blower-Suction Cleaner:** It's a snap to rid all your equipment of damaging dirt, dust, and grit with this portable cleaning tool. Write for more data. Clements Mfg. Co.

### TRANSFORMERS

**594—See page 133. Transformers:** Mail coupon on page 133 for additional information on Stockwell distribution and power transformers for fast, reliable service. Stockwell Transformer Corporation.

**595—See page 39. Transformers:** Send coupon on page 39 for Bulletin P550 on Powerstat Variable Transformers. Complete with application and design information, ratings, diagrams and dimensions. The Superior Electric Co.

### TURBINES

**596—See page 4. Terry Turbines:** Write for bulletin giving interesting facts about the outstanding features that make Terry Solid-Wheel Turbine such a dependable driver. The Terry Steam Turbine Co.

### VALVES

**597—See page 124. Valves:** New catalog shows Sims valves fit any pump—how they work—efficiency and comparison charts. Sizes from 2¾" to 15½". Write for free copy. Sims Pump Valve Co., Inc.

**598—See page 33. Gate Valves:** Write for free bulletin describing Darling rubber lined gate and check valves. Specific recommendations also furnished on Darling valves for every need. Darling Valve & Mfg. Co.

**599—See page 42. Crane Valves:** Dependable quality Crane valves insure low maintenance costs. Ask your Crane representative for a demonstration or write for full details. Crane Co.

**600—See page 26. Forged Steel Valves:** Send coupon on page 26 for literature covering Edward Fig. 4448 series all purpose forged steel valves. Edward Valves, Inc.

**601—See page 144. Automatic Valves:** Write for Bulletin S-3 which describes Golden-Anderson cushioned engine stop valves. Mechanically or electrically tripped. Golden-Anderson Valve Specialty Company.

**602—See page 122. Everlasting Valves:** Write for bulletin describing Everlasting Valves. Ingenious design, simple sturdy construction, and long trouble-free life with low manitenance expense. Everlasting Valve Co.

**603—See page 9. Renewable Composition Discs:** Write for folder "A Guide to Correct Disc Selection" . . . also the "Jenkins Disc Selector", a handy wall chart listing recommended discs for all common services, temperatures, and pressures. Jenkins Bros.

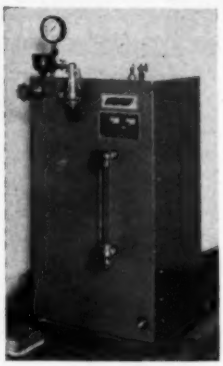
**604—See page 125. Blow-Off Valves:** Unit Tandem Blow-Off Valves constructed with special strength and toughness to withstand severest blowdown conditions. Write for Bulletin B-433. Bulletin B-424 describes lower pressure blow-off valves. Yarnall-Waring Company.

**605—See page 47. Check Valves:** Write today for catalog with complete technical information on Chapman Tilting Disc Check Valves. The Chapman Valve Manufacturing Co.

*( Continued on page 150 )*


# PROCESS STEAM
## Hot, dry—and *when* you want it

With a Speedylectric Boiler you can have the steam you need—for precise control of heating temperatures — platens, ovens, rolls, jacketed kettles, and other process equipment — *at the flick of a switch!*



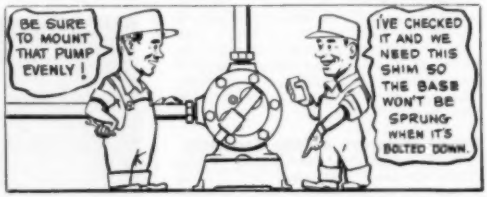
Series 1½

- Process temperatures up to 565°F
- Automatic non-fluctuating pressure control . . . self-regulating — dependable — no moving parts — no maintenance problems
- Simple installation—no long pipe lines . . . no flues or chimneys . . . no fire hazards
- 98.5% *overall efficiency!*

Write for illustrated literature. Manufactured by the maker of the famous Speedylectric Steam-Jet Cleaner . . . world's finest steam cleaner for machinery, industrial housekeeping, paint stripping, etc. Write for Bulletin 74B.

*Speedylectric representatives in all industrial areas.*

**Livingstone Engineering Company**
*Manufacturers of* Steam Generator
**100 Grove Street • Worcester 5, Mass.**




No. 1 of a Series

## HOW TO GET THE MOST WORK OUT OF YOUR
# VIKING PUMPS

**When mounting a Viking Rotary Pump and bolting it down, be sure that the base is not sprung. Bolting the pump down over an uneven surface may cause binding and heating in the stuffing box. It may cause working parts of the pump to bind and wear beyond repair in a short time. The pump must be free enough to turn the shaft by hand.**

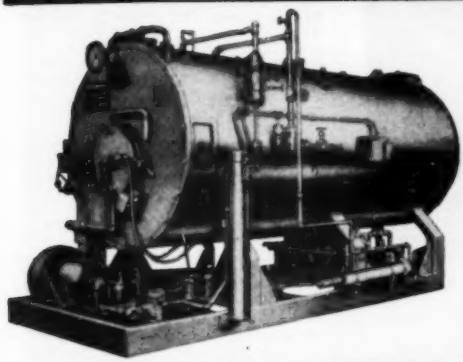
**Get EXTRA wear out of your Viking Pumps by giving them EXTRA care. The Viking Service Manual tells you how. It's a handy, illustrated booklet giving you practical help in mounting, operating and maintaining Viking Pumps. Write for your copy of Manual G today. It's FREE.**

VIKING
AN HONORED NAME IN PUMPING

See Our Catalog in SWEETS

**Viking** Pump Company
Cedar Falls, Iowa

# MODERNIZE with the AMESTEAM GENERATOR



● COMPLETE ● COMPACT

● ACCESSIBLE ● EFFICIENT

● AUTOMATIC

10 to 500 h. p.—
15 to 200 lbs.

*Here are the facts!*

WRITE FOR YOUR COPY

**AMES IRON WORKS**

BOX 909 OSWEGO, N. Y.

*Builders of Better Boilers since 1848*

Manufactured under
License in Canada by VOLCANO, Ltd., Montreal, P. Q.

# CLEANS *Fouled Heat Exchanger Tubes QUICKLY...*

## WILSON TP-301 CLEANER

This high speed tube cleaner is designed to increase output and minimize down-time. The improved Model TP-301 is the only tube cleaner which can remove deposits from completely plugged heat exchanger tubes . . . and other fouled straight tubes heretofore not considered practical to clean.

Many improvements, resulting from years of field experience, have been built into the new TP-301 cleaner.

- **MORE POWERFUL**—operating speed up to 3500 RPM at 90 psi utilizing 130 cfm.
- **LIGHTER WEIGHT**—only 15 lb.
- **SHORTER**—only 13" overall.
- **INCREASED CAPACITY**—from ⅜" up to 2½" or even 3" O.D. tubes up to 40 ft. in length.
- **LOW AIR PRESSURE**—operates on air pressure as low as 50 lb.
- **LOW HEAD ROOM NEEDED**—minimum practical working head room 5 ft.
- **COSTS LESS** than previous models.

**VARIOUS CARBIDE BITS AVAILABLE**

*Send for Bulletin giving complete details on this man-hour and money-saving tube cleaner*

**WILSONIZE TO ECONOMIZE**

**THOMAS C. WILSON, INC. 21-11 44th AVENUE, LONG ISLAND CITY, N.Y.**

CABLE "TUBECLEAN" NEW YORK

TW-7944

**WILSON**

**TUBE CLEANERS · TUBE EXPANDERS**

## SURE CURE FOR DOUBLE TROUBLE

Oxy-acetylene welding is a lot safer and faster today because of a unique hose called Twin-Weld.® Invented and patented* by Hewitt-Robins, it does away with the dangerous tangle of individual oxygen and acetylene lines that formerly plagued welders.

Twin-Weld combines both hoses in one compact, molded unit . . . neat, flexible, non-kinking . . . yet readily separates for coupling to tanks and torch. It saves time in getting welding equipment into operation, makes it easy to reach the work, change position at will or work in close quarters on difficult jobs.

Making better industrial hose and belting has been a habit at Hewitt-Robins for almost a century. Twin-Weld is only one of many Hewitt-Robins "firsts" that have made the handling of fluid and solid bulk materials faster, more dependable, more efficient, more economical.

If you want the benefit of an international experience in solving your materials handling problem . . . whether in hose, belting, vibrating machinery or complete belt conveyor systems . . . get in touch with Hewitt-Robins.

*U. S. Patents 2,122,355 & 2,136,220

**HEWITT HR ROBINS**

*Executive Offices:* 370 Lexington Avenue, New York 17, N. Y.

**HEWITT RUBBER DIVISION:** Belting, hose and other industrial rubber products
**ROBINS CONVEYORS DIVISION:** Conveying, screening, sizing, processing and dewatering machinery
**ROBINS ENGINEERS DIVISION:** Designing and engineering of materials handling systems

Hewitt-Robins is participating in the management and financing of Kentucky Synthetic Rubber Corporation

## Readers' guide to advertised products

*( Continued from page 148 )*

**606—See page 162. Butterfly Valves:** Rockwell designs many valves for special applications. Write for catalog describing complete line of standard valves to 72" pipe size—manual or automatic controls. Also, ask to receive "Rockwell Valve News" monthly. W. S. Rockwell Company.

**607—See page 21. Aloyco Valves:** Think of Aloyco valves first if your plant deals with corrosion or must guard everywhere against product contamination. Ask for specialized engineering assistance. Alloy Steel Products Co., Inc.

### WATER TREATMENT

**608—See page 119. Water Conditioning System:** See page 119 for list of advantages of Graver water treatment with hot zeolite. Write for technical articles "Hot Zeolite Softening" and "Factors in Hot Process Softener Design and Operation." No obligation. Graver Water Conditioning Co.

**609—See page 154. "New Bulletins":** Make reservations now, on your letterhead, for your free special copy of "New Bulletins" featuring power industry. Refinite Corp.

**610—See page 43. Worthington Hot-Z-System:** Tell us your conditions of service and get our recommendation in terms of dollars and benefits. Write today. Worthington Pump and Machinery Corporation.

**611—See page 13. Filming Amines:** Send for Technical Paper #121, "How Filming Amines Prevent Steam and Return Line Corrosion". Achieves as high as 99 percent reduction in corrosion rate! Write today. W. H. & L. D. Betz.

**612—See page 145. Concentrol:** Concentrol stops foaming by affecting a rapid change in surface tension of steam bubbles which permit coalescence of small steam bulles of larger size. This eliminates foam buildup and subsequent carryover. Free Data Sheet available. The Bird-Archer Company.

**613—See page 157. Water Treating Equipment:** Get your copy of fact-filled bulletins giving complete data on manual or automatic equipment in all sizes, types and capacities. Hungerford & Terry, Inc.

**614—See page 151. Cuno Flo-Klean Filter:** Makes raw water suitable for many plant services, keeps recirculated water clean, pays for itself in quick time. Write today or send coupon for full information. Cuno Engineering Corporation.

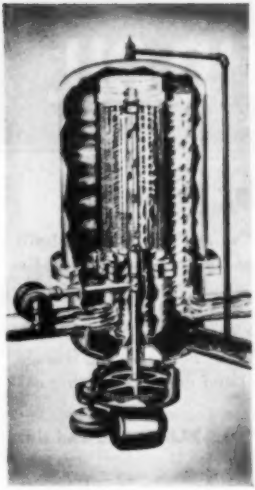
### MISCELLANEOUS

**615—See page 173. Power Plant Communication Systems:** Write for booklet "Power Plant Communication Systems" showing Gai-Tronics at work under the most difficult sound conditions. Or write for free demonstration. No obligation. Gai-Tronics Corp., Subs. of Gilbert Associates Inc.

# Clean Raw Water
# Reclaim Process Water

## with this low-cost non-stop strainer

Abrasion and corrosion-resistant Cuno FLO-KLEAN handles full flow—cleans itself and discharges accumulated trash *without interrupting* flow. Can be installed in some remote place and forgotten. Some users have saved enough to pay cost of FLO-KLEAN in a few months!



CUNO

*Fluid Conditioning*

**Removes More Sizes of Solids from More Kinds of Fluids**

Strain fuels, lubricants, process fluids, etc.—AUTO-KLEAN
Filter fuels, lubricants, process fluids, etc.—MICRO-KLEAN
Clean raw water, recirculating water, etc.—FLO-KLEAN

## Aid for "Dry" Communities ... Relief from High Water Bills

Many industrial plants have solved the scarce-water problem by using raw river or lake water for plant services.

Passing such water through a Cuno FLO-KLEAN effectively strains out trash and cleans the water at rates up to 20,000 gpm, with negligible pressure drop.

Other plants use FLO-KLEAN for reclaiming used process water. Even when water isn't scarce, it still costs money, particularly if it has been heated for process work.

On this basis, Cuno FLO-KLEANS have paid for themselves in as short a time as six months.

They even reclaim their own backwash water—not wasting a drop!

## Continuously Cleanable Permanent

The Cuno FLO-KLEAN positively removes all solids larger than specified. May be specified from .030 in. down to .0025 in. Operation is continuous—because the strainer is continuously self-cleaning. Therefore, full flow can be handled without needing a duplex installation.

With continuous backwash cleaning of the cartridge and automatic top and bottom blow-down, the FLO-KLEAN needs no attention.

All-metal construction is abrasive and corrosion-resistant.

Cuno Engineering Corporation
Dept. 141E, South Vine Street, Meriden, Conn.

Please send information on Cuno FLO-KLEAN for straining raw water....reclaiming process water....

Name.....Title.....

Company.....

Address.....

City.....Zone....State....

Please attach to business letterhead

# New equipment and developments

*( Continued from page 22 )*

plete, self-contained packing unit. Particularly valuable in the design of new equipment, it is designed for maximum sealing efficiency in minimum packing depth, to save space and cut machining costs. No follower or header rings are needed, which saves assembly time. Each ring centers itself perfectly on the preceding ring, thus reducing the chance of human error. In service each lip is always exposed to fluid pressure. This provides positive sealing and since there is no dependency on gland pressure for sealing, friction is reduced and there is less wear on both rod and packing.

This packing is offered in varied compositions to suit different services, and is furnished in sets of endless or split rings for shafts 5/8 in. dia and up.

## 21—CONTROL CABLE IS MORE DURABLE

A moisture-resistant multi-conductor control cable has been designed by General Electric Co. around an open-weave, Neoprene-treated Fiberglas cloth. The cloth is slit into tape and wrapped around the conductors as they are stranded. During extrusion of the jacket, porosity of the open-weave tape permits free flow of the rubber into the valleys between the conductors.

Fiberglas yarn reinforcement is used in the cable's rubber center filler, with the result that the new cable has considerably improved resistance to crush, deformation and moisture damage. Unlike the conventional jute-filled type, the inorganic Fiberglas material will not rot, and there are no loose particles to foul individual conductors.

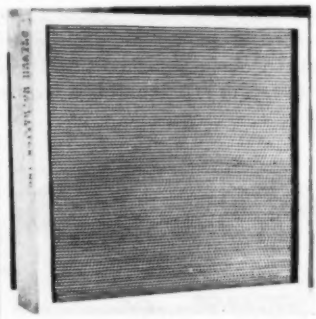
## 22—SPRINKLER HEAD CAN BE SEALED OR OPEN

The Rockwood Sprinkler Co. has recently developed a fire extinguishment head known as the Rockwood T-Head, which they claim is a further step in the development of more efficient use of water in fire extinguishing. It is engineered and designed for use in fixed piping systems and can be

used as either a sealed or open head. The sealed head combines the principles developed in Waterfog with the construction of the figure "4" fusible element of the regular Rockwood sprinkler head.

## 23—AIR FILTER IS ABSOLUTE

An absolute air filter, developed originally for the Atomic Energy Commission and claimed capable of removing better than 99.98 per cent of all dust, smoke, fumes, radioactive particles, spores and other microscopic foreign matter from the air, is being produced in quantity for commercial use by Cambridge Corp. Especially applicable wherever absolutely clean air is needed, the filter is being made at present in two standard sizes with rated capacities of 500 and 850 cfm. Individual units may be arranged in multiple banks of fil-




NON-FLUID OIL

TRADE MARK REGISTERED

**For Positive Bearing Protection**

NON-FLUID OIL is *all* lubricant which, because of its built-in adhesiveness, provides a constant film to shield highly finished surfaces of ball and roller bearings from attack by moisture and acid fumes. Furthermore, NON-FLUID OIL forms a perfect lubricating seal between the rotating shaft and housing to exclude dirt and moisture. Stable in both use and storage, NON-FLUID OIL is strictly neutral and does not develop corrosive free fatty acids in service.

Send for free testing sample of NON-FLUID OIL and Bulletin No. 506.

**NEW YORK & NEW JERSEY LUBRICANT COMPANY**

292 MADISON AVENUE, NEW YORK 17, N. Y.—WORKS: NEWARK, N. J.

WAREHOUSES: Atlanta, Ga. • Birmingham, Ala. • Charlotte, N. C. Detroit, Mich. • Chicago, Ill. • Columbus, Ga. • Greensboro, N. C. Greenville, S. C. • Providence, R. I. • St. Louis, Mo.

*NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.*

ters to handle any desired amount of air.

Static pressure resistance when new is less than one inch of water. Dimensions of the filters are 24 by 24 by 5-7/8 in. deep for the 500 cfm size and 11-1/2 in. deep for the 850 cfm size.

**Additional information on new equipment and development items is available. Use card inserted between pages 140 & 141**

## 24—MAGNETIC OUTLET FINDER USES PERMANENT MAGNET

Working on the magnetic draw principle and designed to locate concealed outlets in steel underfloor raceways, a magnetic outlet finder has just been announced by National Electric Products Corp. In use the finder is placed on the floor surface—wood, concrete or linoleum—and moved about by hand. There is a noticeable draw when the finder passes over the steel duct, and draw increases as the finder approaches a submerged outlet. The maximum pull is exerted when the finder is centered over the outlet, thus giving positive identification and location for cutting through the finished floor.

Inside a brass housing is a permanent magnet, which has a floor penetration range up to 1-½ in. The magnet is designed for life-long service and the compact construction assures ease and simplicity of operation. Size of the magnetic outlet finder is 2-¾ in. dia. and 2-¾ in. high, the weight being approximately 2-¼ lb.

## 25—SPEED CONTROL HAS SELENIUM RECTIFIER

A speed control known as Type 1700-B Variac is claimed by the manufacturer, General Radio Co., to offer several new features for 1/3 hp motor control, the most important of which are instant starting and freedom from tube replacement. These features are made possible by the use of selenium rectifiers, tests on which indicate almost indefinite life expectancy for ordinary applications.

With this control standard compound-wound motors having five leads can be reversed by means of the switch on the

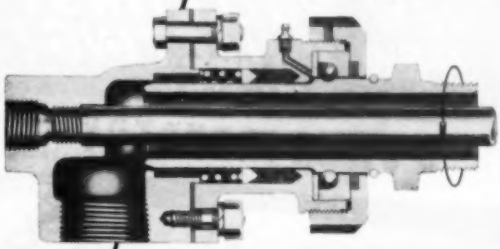
*( Continued on page 154 )*


*Users REPORT many ADVANTAGES*

POWER savings up to 50% . . . long, leakproof service . . . very low requirements for maintenance . . . quick, easy accessibility of parts . . . better temperature control . . . ability to withstand vibration and hard usage—these are just a few of the ADVANTAGES reported by the many users of BARCO REVOLVING JOINTS!

**AMERICAN FINISHING COMPANY MEMPHIS, TENN.**

User of hundreds of joints on calenders, sanforizers, dry cans and chill rolls, Mr. S. Bernson, Chief Engineer, American Finishing Company writes, "We are well pleased . . . I hope to have entire plant equipped with Barco joints." Formerly, it was considered exceptional to have 75% of joints leak-free. Today, with the change-over to Barco nearing completion, virtually 100% leak-free service is the rule.



*IMPROVED TYPE IBR REVOLVING JOINT*

Here is the new, *improved* Type IBR Barco Revolving Joint! It is precision-built in *single flow* and *syphon styles* for handling steam, water, air, oil, gas, or chemicals. Note wide spacing between bearings. Inherent low torque is little affected by pressure, speed, or temperature. Light running action minimizes wear, permits free-floating installation. No adjusting necessary. For the complete story, send today for new Bulletin No. 300. *Worldwide sales and service; ask for recommendations.* BARCO MANUFACTURING CO., 1831K Winnemac Ave., Chicago 40, Ill. In Canada: The Holden Co., Ltd.

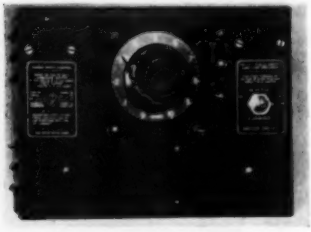
**BARCO REVOLVING JOINTS**

*The Only Truly Complete Line of Flexible, Swivel, Swing, and Revolving Joints*

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

# New equipment and developments

*( Continued from page 153 )*

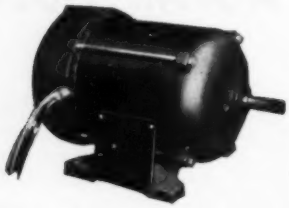


control. Strong dynamic braking is obtained in the stop position, although the motor can be stopped without dynamic braking if the a-c input switch is used. Starting is instantaneous and the short-period overload capacity is very large. A time-delay magnetic circuit breaker protects the control and motor in the event of a stall. Speed can be controlled from rated motor speed down to zero. The rpm rise in speed between full load and no load is roughly the same at all speeds.

## 26—CAPACITOR MOTORS TOTALLY ENCLOSED

General Electric's Tri-Clad line of single-phase capacitor motors has been extended to include a totally enclosed fan-cooled construction, announces the company's Small and Medium Motor Div. Features of the design include starting capacitors and switch mounted within the frame to provide maximum protection with minimum space.

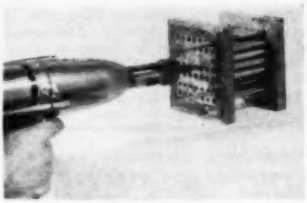
Available in rating of 1, 1-½, 2, 3 and 5 hp, the line was developed for use where extra severe conditions of dirt, grit or moisture are encountered. It is also offered in explosion proof and dust-explosion proof construction for installation in hazardous



locations. Typical applications are: coal stokers, exhaust fans, and fuel pumps. Except for the 5 hp size, which uses 230 v only, the new motors operate on 115/230 v, 60 cycle power supply.

## 27—TUBE DE-EXPANDER SAVES TUBE SHEET

A line of precision tube expanders, coupled with a series of de-expanding tools, is currently being manufactured by Franklin Mfg. Co. The expanders are available for sizes from ⅜ in. x 16 ga to 1 in. x 16



ga tubes and are equipped with any of three types of ball bearing expander collars, which hold and position the tube during expanding. Also offered are electronic tube expander controls for expanding and flaring in one operation.

The de-expanding tools are used in pairs of right- and left-hand and are operated by rotary impact tools with the result that the tube metal flows into the tool flutes until shrinkage permits rotation of the tube and subsequent drifting from the tube sheet.

## 28—TEMPERING VALVE WILL NOT FATIGUE

A tempering valve, factory set to deliver water at approximately 140 F to faucets or plumbing fixtures, is announced by Taco Heaters, Inc. Constructed of bronze and stainless steel, this Type B valve is avail-

able in ½ and ¾ in. sizes with two unions for easy assembly in industrial and small commercial installations.

The manufacturer claims that the patented, hermetically sealed thermostatic element avoids the use of bi-metal, bellows or volatiles and will not fatigue or corrode.

## 29—THERMOMETER CHECKS OIL TEMPERATURE

A cupcase thermometer, narrow enough to fit into two-in. gage pipes in oil storage tanks, is announced by Tagliabue Instruments Div., Weston Electrical Instrument Corp. Accurate and easy to read, the new model also meets ASTM specifications.

Known as TAG Model 8652, the thermometer has a cup capacity of 100 milliliters. The thermal inertia resulting from

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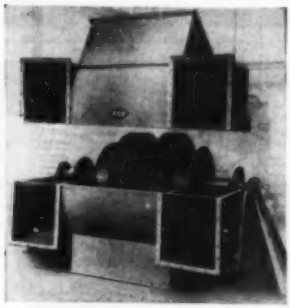
the larger capacity provides greater resistance to temperature change as the thermometer is raised from reading depth and passes through varying temperatures at other levels, permitting accurate volumetric corrections for readings above or below 60 F, the sale price temperature. The bulb is positioned 5/8 in. from the nearest wall of the cup and almost centered to provide the greatest possible lag. Made of non-sparking metal, the cup measures 1-¾ in. in dia. Overall length of the instrument is 16 in. The thermometer has a red mercury column with lens front tubing and is available in two scale ranges; one from 0-180 F and the other from -30 to 120 F, both with one degree scale graduations.

**Additional information on new equipment and development items is available. Use card inserted between pages 140 & 141**

### 30—FORCED DRAFT FAN IMPROVES DIFFUSION

A forced draft fan embodying three new features that improve aerodynamic characteristics and more efficient conversion of velocity to static pressure has been developed by Prat-Daniel Corp. The features claimed are: large, deep inlet cones streamlined to reduce turbulence at the inlet; open space between the wheels of double wheel



models, permitting complete four way diffusion of the air leaving the wheels; and an oversize housing to assist diffusion.

Performance shows peaks of efficiency and horsepower curves falling well within the proper fan selection range, making possible selection for maximum efficiency without overloading. Blades are designed to offer a nearly perfect aerodynamic flow across the leading and trailing surfaces, further contributing to smooth flow of air through the fan.

### 31—PURIFIER DELIVERS CLEAN STEAM

The first line of low-cost purifiers has just been announced by the V. D. Anderson Co. This purifier is of the internal type and has a wide range of applications inside steam drums, flash tanks, evaporators, packed towers, bubble-cap towers, deodorizers and stills. Called the Anderson Hi-eF purifier, the unit is guaranteed by the manufacturer to deliver vapor with 1.0 ppm or less of total solids. The purifiers are

*( Continued on page 156 )*

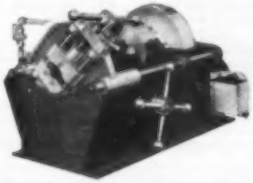

Sure it threads faster and easier... it's a TOLEDO

SPEED PRODUCTION... CUT COSTS!

He's happy about the whole set-up! His boss always makes sure that genuine TOLEDO Pipe Tools are on the job! These are the tools preferred by better mechanics everywhere for nearly half a century . . . *easy handling, faster cutting.*

Don't be switched—insist on TOLEDO for the finest in pipe threading and cutting tools and power machines! See how quickly Toledo dies take hold . . . how easily they cut smooth, accurate threads. Check the many advanced features of Toledo Pipe Tools . . . designed to speed the work and assure fast make-up and trouble-free joints. You'll be better satisfied with Toledo dependability! Write for catalog. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

Complete Toledo line includes Hand Tools, all pipe sizes, ⅛" to 12" and ¼" to 1" bolts. Power pipe machines, up to 2" and 4" capacity. (Above)—Toledo No. 1R Threader, 1" to 2" pipe.



Toledo #999 2" pipe machine, wheel or knife cut-off.

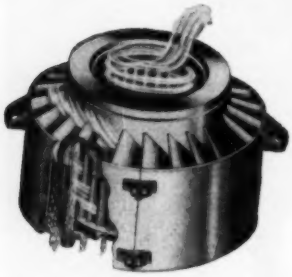
RELY ON THE LEADER

TOLEDO

PIPE TOOLS . . . POWER PIPE MACHINES . . . POWER DRIVES

# New equipment and developments

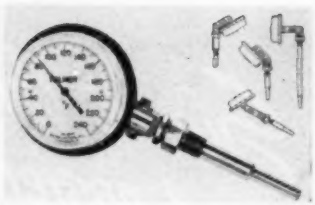
*( Continued from page 155 )*



available in a complete range of sizes and made of various materials. Sizes 4 in. through 10 in. are designed to pass through standard 10 x 16 in. and 11 x 15 in. elliptical manholes sizes 12 in. through 36 in. for standard round manholes; larger sizes 39 to 72 in. can also be furnished.

## 32—THERMOMETER EASILY ADJUSTED

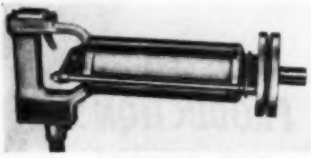
A mercury actuated 4-½ in. dial thermometer, available in three models, is being produced by Palmer Thermometers, Inc. With either rigid stems or flexible armor



up to 60 ft in length, and arranged for either direct, wall or flush mountings, these thermometers have well-protected, precision-built movements, guaranteed accuracy, non-reflecting white faces and adjustable pointers. Except for the flush mounted models, the thermometers have cases adjustable for easy reading from any angle.

## 33—ELECTROMAGNETIC HAMMER DRILL ROTATES BIT

An electromagnetic hammer drill denoted as Model No. 17-RO has been added to the line of electric hammers and hammer drills manufactured by the Syntron Co. Designed for highspeed, quantity hole

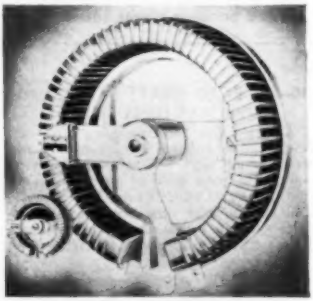


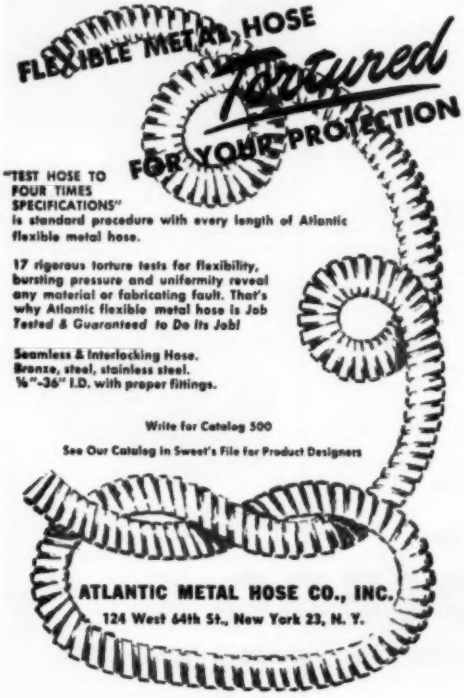
drilling in concrete, brick and stone it has a 1-⅛ in. drilling capacity, weighs 21-½ lb, and is available for operation from 110 or 220 v a-c.

Automatic rotation of the carbide-tipped, spiral-fluted drill speeds up hole drilling, eliminates manual turning of the drill chuck and reduces fatigue. Rotation of the bit is accomplished by a rubber ratchet mechanism actuated by the recoil of each blow of the hammer's piston, which is at the rate of 3600 blows per min.

## 34—ENAMEL RHEOSTAT HAS HINGED CONTACT ARM

A line of vitreous enamel power rheostats is being placed in production by P. R. Mallory & Co., Inc., manufacturers of electric, electronic and metallurgical products. Rheostats will be available in seven sizes, ranging from 50 to 500 w. They will

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"TEST HOSE TO FOUR TIMES SPECIFICATIONS" is standard procedure with every length of Atlantic flexible metal hose.
17 rigorous torture tests for flexibility, bursting pressure and uniformity reveal any material or fabricating fault. That's why Atlantic flexible metal hose is Job Tested & Guaranteed to Do its Job!
Seamless & Interlocking Hose.
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⅛"-36" I.D. with proper fittings.
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ATLANTIC METAL HOSE CO., INC.
124 West 64th St., New York 23, N. Y.

A—Deep crack. B—Tamping Smooth-On in. C—Crack completely sealed.

**If You've Never Used SMOOTH-ON, *read this:***

Smooth-On No. 1 Iron Cement is a metallic powder which you mix with water to the consistency of putty. You tamp it, while still soft, into a crack or hole, making sure to force it against all surfaces. With Smooth-On you don't need to use heat or special gadgets. As it hardens, it expands slightly, clinging tightly in place. The repaired part is ready for use as soon as Smooth-On sets hard. Keep Smooth-On handy for both emergency and routine maintenance repairs. Buy it in 7 oz., 1 lb., 5 lb., 20 lb., or 100 lb. size. If your supply house hasn't Smooth-On No. 1, write us.

**FREE 40-PAGE REPAIR HANDBOOK**

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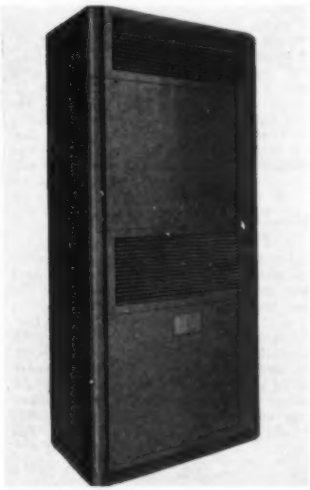
*Do it with* **SMOOTH-ON**
THE IRON REPAIR CEMENT OF MANY USES

be interchangeable with the vitreous enamel power rheostats produced by the rest of the industry, but feature an exclusive patented hinged contact arm, which insures long life and freedom from burn outs.

## 35—AIR CONDITIONER OPERATES QUIETLY

A quiet, self-contained air conditioner designed to save floor space and to cut service and maintenance to the minimum has been announced by the Trane Co. Spring mounting of the compressor and full glass fibre acoustic and thermal insulation of the streamlined casing contribute to quiet operation. The semi-hermetic compressor operates with little or no servicing. The two-knob control panel in the front of the unit cooler permits the owner to set the desired temperatures, operate the unit for either heating or cooling, or fan for ventilation.

Available in 3, 5 and 7-½ ton capacities for spot installations, this self-contained air conditioner is a complete packaged system, requiring only one electrical and three piping connections.



**Additional information on new equipment and development items is available. Use card inserted between pages 140 & 141**

## 36—PRESSURE RECORDER RANGE 0.5 - 10,000 PSI

An Electro linear stabilized pressuregraph with operation based on a system of carrier modulation is announced by Electro Products Laboratories. Simply installed, it provides accurate linear measurement and records pressure-time studies of static, dynamic and transient pressures in air, gases, water and viscous liquids. The unit consists of an electronic pick-up connected to the pressure study region, an associated electronic circuit and power supply, and a cathode-ray oscilloscope.

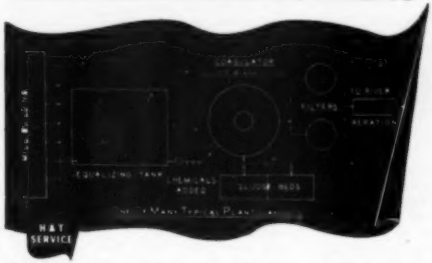
Features claimed are: linear outline viewed directly on oscilloscope; drift and temperature stabilized; pressure range from 0.5 to 10,000 psi; frequency response from 0 to over 20,000 cps; 200,000 separate pressure measurements per second; and use of up to 200 ft of pick-up cable.

## 37—ROTARY JOINT HANDLES HIGH PRESSURES

The Johnson Corp. has announced availability of self-supporting Type S Johnson joints in heavy duty construction suitable for operating pressures up to 250 psi. The type S is used widely in industry wherever heating or cooling agents must be admitted to rotating rolls. This is a specialized version of the regular Johnson rotary pressure joint, which was developed specifically to combat misalignment on such machines as calenders where considerable lateral movement of rolls is encountered. Previously its

*( Continued on page 158 )*


**HOW HUNGERFORD & TERRY TREATS INDUSTRIAL WASTE WATER PROBLEMS**



1. Survey of flow rates, quantity of water, available equipment, space, pipe sizes, and other information.
2. Analysis of representative waste water samples, to determine the most efficient and economical treatment. A complete report on treatment and treatment cost is submitted.
3. Build model waste water treating unit from our laboratory findings. A quantity of waste water is passed through the model in the presence of plant representatives. Samples are analyzed to show treatment process.
4. A formal proposal is prepared and submitted with a schematic drawing to show operating arrangement and complete guarantees of EFFLUENT capacity and quality.
5. Work in close co-operation with all national, state and local government authorities.

*Write For More Information*

**HUNGERFORD & TERRY INC.**
**Clayton 1, New Jersey**

"TROUBLE FREE" *Control . . .*

**TRERICE**
**SELF-OPERATING REGULATORS and DIAL THERMOMETERS**
*Constant Temperature Regulation for*
• HOT WATER TANKS • PASTEURIZERS • PRE-HEATERS
• STORAGE ROOMS • VATS • PLATING TANKS
• COOKERS • FEED WATER HEATERS • WATER JACKETS

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NEW SUPER REFRACTORY for Severe Conditions

**Resists Severe Erosive Action of Gases at All Temperatures to 3000° F.**

**Reduces Repair, Expense in Outage, Materials and Labor**

- ✓ New or old fire brick linings bonded with R & I Super #3000.
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The greatly increased refractory life of these and other applications proves the remarkable ability of Super #3000 Refractory Cement to stand up under severe operating conditions at low temperatures as well as high temperatures up to 3000°F.

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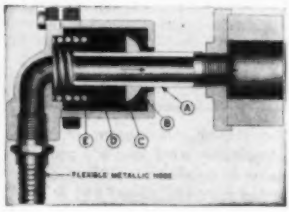
R&I SUPER #3000 Refractory Cement

REFRACTORY & INSULATION CORP.

118 Wall St., New York 5, N. Y.

# New equipment and developments

*( Continued from page 157 )*




application was limited to a ceiling of 150 psi maximum operating pressure. The new type retains the packless, self-lubricating and self-adjusting features of their standard joints, with pressure itself acting as the sealing force.

## 38—REGULATOR USES INVAR ROD

An expansion stem type temperature regulator known as their "Accritem" regulator is being manufactured by the Powers Regulator Co. Used to maintain liquids or air at any temperature desired by controlling pneumatic or water operated diaphragm valves or dampers, the regulator comes in ranges 50-250 F and 150-350 F. It requires compressed air or water at 15 psi pressure, has adjustable sensitivity and overheat protection and is simply constructed to withstand vibration and insure long life. The sensitive element is an Invar rod enclosed by a bulb 12 in. long with ½ in. IPS connection. The regulator head itself measures 2-7/8 x 3-5/8 in. Some applications are for instantaneous water heaters, heat exchangers, jacket water for air compressors, dry bulb and dew point control.

## 39—DIP PROTECTS WOOD FROM DRY ROT

Another member of the Fungus-Ban family is announced by The Wilbur & Williams Co. It is a copper napthanate dip for wood to be exposed to immersion in water. This product imparts a green color to the wood, as indication that it has been treated, and gives primary protection against dry rot. The preservative treatment can be painted over with ship bottom paint or normal paint after 24 hr drying as it is of a non-crystallizing nature. Made to meet Federal Specifications MIL-W-906 Type 1 or Class A.

## 40—ION EXCHANGER EMPLOYS RESINS

An ion exchange unit for the treatment of water in steam heating plants has been developed by the Permutit Co. To be known as the "Dual Bed" ion exchanger, the unit eliminates the need for much elaborate equipment and for handling such dangerous chemicals as caustic soda, sulphuric and hydrochloric acids during the regeneration process. The new unit will find its principal application in industrial plants for the conditioning of boiler feed water where prevention of scale formation and reduction of corrosion are major problems. The "Dual Bed" ion exchanger provides simple, inexpensive water softening and lowers or removes alkaline and sulfate contents. The unit cannot produce an acid water during the treating step or acid waste waters during regeneration. It employes new type resins that are regenerated with plain salt.

## 41—TOOL CHEST, WRENCH BOXES REDESIGNED

Addition of a PROTO master tool chest and redesign of two socket set boxes have been announced by Plomb Tool Co. The new tool chest, No. 9997, measures 27 x 12 x 15 in. high. It has two full-width two-compartment drawers, four half-width three-compartment drawers, a full-width top section partitioned into three compartments and a tote tray with three compartments. Features of the chest are heavy-gage steel welded construction, rounded corners, dual-action drawer slides, full length piano type top hinge and a drop front with tumbler lock that covers all drawers when the chest is closed.

Both the PROTO No. 5295 and 5495 socket wrench boxes, for ⅜ and ½ in. drive sets respectively, have been completely redesigned for strength and appearance by rounding the corners and using a drawn one-piece construction for top and bottom.

## 42—MANUAL CONTROL VALVE FEATURES BABBITT SEAT

Heavy-duty valve, No. 788, produced by R-S Products Corp., is equipped with totally enclosed gear reduction drive, extended shaft and floor stand. The sealing of water pressure is obtained by utilizing a babbitted seat in the body and Monel or stainless steel welded to the periphery of the valve disc. Such metal-to-metal seat gives satisfactory commercial shut-off in most applications. For instance, with a 350 ft head of ambient water, a 36 in. valve has a leakage of only 50 ghp. Remote, automatic or semi-automatic controls are also available for this type of valve.

# New bulletins and catalogs

*( Continued from page 32 )*

application of the instrument to presses, factory machinery, refrigerators, pumps and motors, conveyers, continuous ovens, furnaces, etc. Liberally illustrated with photos of various models, reproductions of chart records, and operation drawings. Photographs of several installations also included. In addition, brief descriptions of other recorders are given. The Bristol Co.

**241—Humidity Control Instruments.** Data sheet 10.5-4 describes method of humidity measurement that makes possible direct readings from remote locations. Includes photos of units along with diagrams showing applications in typical air-conditioning systems. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

**242—Pyrometer.** Two portable pyrometer models are described in bulletin PPY-1. Useful where temperatures of molten aluminum, zinc, lead, tin, brass and other non-ferrous alloys must be measured before pouring; where liquids must be held to correct temperatures to assure proper consistancy; and where temperatures of metals in galvanizing kettles must be maintained to provide uniformity in coating etc. Specifications on thermocouple holders and tips are also contained in the 2-page sheet. Wheelco Instruments Co.

**243—Solenoid Valves.** Direct operated solenoid valves are covered in 8-page catalog V. Lists sizes from ½ to 3 in.; valves for normally open or normally closed service; stainless steel or Jenkins disc seats; valves with special dashpot construction to stop water hammer; 3-way solenoid valves, etc. All are built for pressures up to 150 lbs, quick-opening and free of any pilot valves or auxiliary pistons, according to the booklet. Installation drawings included. The Johnson Corp.

## BULK HANDLING EQUIPMENT

**244—Feeders & Conveyers.** Catalog 830, 84 pages, tells the whole story of electric vibrating feeders and conveyers for handling and controlling the flow of solid materials. Gives detailed description of basic design and operating principles as well as specific technical information concerning standard and special applications. Numerous photgraphs, sketches, diagrams and tables show standard designs, sizes, capacities and applications. Of particular interest is table of densities of typical solid materials as they occur in material handling. The Jeffrey Mfg. Co.

**245—Conveyer Belt Accessories.** Spring type multiple-blade belt cleaner and roller type holdback are illustrated and described in 4-page bulletin 651. Drawings show typical mounting arrangements and photographs portray typical installations. Stephens-Adamson Mfg. Co.

**246—Pulverizers & Dust Collectors.** Series of bulletins, including 50-page brochure, should aid in solving grinding and collecting problems. Units for fine and ultra-fine grinding along with collectors are pictured and described. Diagrams show 19 different installation arrangements. Offers data on screens & hammers, materials of construction, dimensions, motors, how it operates and recommended applications. Lists materials to which the units are applicable. Pulverizing Machinery Co.

**247—Ash & Flyash Handling.** Both hydraulic and pneumatic ash and flyash handling systems are covered detailedly in booklet. Compiled in question and answer form, it discusses the elements and advantages of various systems, and disposal schemes, such as pumping to fill area, or pumping to storage sump or dewatering bin for truck removal. Schematic drawings of arrangements under specific conditions, also diagrams of basic arrangements, are included. Beaumont Birch Co.

**248—Storage Silos.** Facts about precast concrete storage systems are presented in 8-page bulletin. Illustrates and describes both solid and air-cell types of staves and lists applications for each. Sketches show details of construction. Installation photos show partly finished and completed units. Briefly describes clarifier tank construction. The Marietta Concrete Corp.

**Bulletins and catalogs reviewed here are yours for the asking. Use card inserted between pages 140 & 141**

**249—Conveyer Idlers & Machinery.** Bulletin 51-81 contains information on latest designs and developments of this equipment. Includes two pages of general engineering information to help in designing and specifying belt idler equipment. Data on lubrication material and techniques are included. Also includes detailed description of zipper bunker seals plus data on belt conveyer trippers. Section contains useful information on correct maintenance procedure. Chain Belt Co.

**250—Vibrating Screens.** Both dry and liquid vibrating screens are covered in 20-page catalog 2377. Descriptive material includes specific information on how to select the right screen and screen cloth; dimension tables, weights, horsepower requirements; and other valuable data. Shows variety of actual installations. Link-Belt Co.

## POWER TRANSMISSION

**253—Speed Reducers.** Fractional hp speed reducers that provide ratios from 25:1 to 1764:1 are illustrated and described in 4-page bulletin HW150. Available with 24 different shaft locations. Diagrams show three typical assemblies. Table of torque output ratings together with dimensions sketch included. Winfield H. Smith Corp.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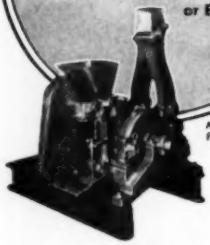

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If your need is for ultra-fine grinds requiring air classification rather than screening, the MIKRO-ATOMIZER is your complete answer. It is an entire system producing perfectly blended grinds in the lower micron range in a single pass at exceptionally low temperature rises.

With its built-in air separator, it is a 3-function machine, grinding, air-classifying and conveying in one operation. Slight adjustments permit varying degrees of fineness. If necessary you can actually produce two degrees of fineness in one operation.

If you have ultra-fine grinding problems don't fail to investigate this 3-function MIKRO.

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Also Makers of the MIKRO COLLECTOR

# New bulletins and catalogs

*( Continued from page 159 )*

**254—Chain Drives.** Catalog HD51 has been compiled to offer simple, quick means of determining interchangeability of various makes of roller and conveyer chains. Additional useful information is supplied that is of value in determining the proper application of chain drives as power transmission or conveying medium. Whitney Chain Co.

**255—Gear-Type Couplings.** Catalog 501 explains the advantages and features of gear-type coupling with fully crowned teeth. Shows how the unit may be used to solve wide range of special power transmission problems. Contains data on shaft sizes, and speed and load capacities. American Flexible Coupling Co.

**256—Magnetic Drive.** Bulletin 1107 is a 32-page publication titled "Precision Speed Control with the Adjustable-Speed Magnetic Drive." The book is technical in scope, and contains complete information both on the magnetic drive and the magnetic amplifier Regutron speed control. Technical information is clarified through the use of many charts, diagrams, and illustrations. Illustrated section covering industrial applications also included. Electric Machinery Mfg. Co.

## PUMPS AND ACCESSORIES

**258—Vertical Turbine-Type Pumps.** Line of vertical, turbine-type pumps are described in 8-page catalog 7228. Recommends such applications as bulk liquid transfer, cooling tower, dewatering and similar services where suction is taken from an open source. Available in single-or multi-stage construction, with sizes from 6 to 30 in., for capacities to 15,000 gpm and pressures to 250 psi. Ingersoll-Rand Co.

**259—Centrifugal Sump Pump.** Bulletin WQ220 covers type VS and VN centrifugal sump pumps. These units which are available in wet and dry pit types, handle clear liquids, sewage and other liquids containing solids and are made in 1½ to 8 in. sizes, capacities to 2000 gpm and heads to 120 ft. The 8-page booklet shows external and sectional views, impeller designs and has dimension and selection tables; also comments on applications. Warren Steam Pump Co., Inc.

**260—Jet Pump.** Cycling jet pump operated by air, gas or steam pressure, said to handle any liquid that will flow through pipe lines, is described in illustrated 4-page bulletin 5030. Uses, advantages, operation, performance and specifications are discussed. Gives dimensions. Penberthy Injector Co.

**261—Rotary Pumps.** Bulletin WQ50, 8 pages, illustrates and describes in detail this rotary type of pump, including both sectional and exterior views, dimensions, selection chaart and specs. Warren Steam Pump Co., Inc.

**262—Packings & Seals.** Improved sealing of power and processing equipment is supplied by anti-frictional, self-lubricating, flexible metallic packing, says series of bounds catalogs. Covers flexible metallic packing, semi-metallic plastic packing, rotary mechanical seals, oil circulating systems and packing tools. Each bulletin tells how to apply and maintain the packing style used, and lists recommended uses for specific conditions. Of particular interest are 4-pages of engineering data including such useful information as conversion tables, areas of circles, weights of metals and liquids, steam temperature at various pressures. Durametallic Corp.

**263—Reciprocating Pump.** Two-color, 8-page data sheet 67A describes 6 in. stroke direct flow pump series. Gives full details of design and construction including dimension and sectional drawings, performance data and pump specifications. Lists applications, including chemical handling, descaling systems, hydraulic systems, and oil field service. The Aldrich Pump Co.

**270—Rotating Pump Valves.** Bulletin VIII tells the whole story of inclined port rotating pump valves, adaptable to all reciprocating pumps. Said to overcome such troubles as valve slam or knock, seat-imprinting of discs, slip, valve-stem and spring breakage. The 4-page booklet gives information on valve types, materials of construction and service applications. Sectionalized photo and cross section drawing show essential features of the unit. Actual case histories show substantial dollar savings over two-year period. Sims Pump Valve Co., Inc.

## TOOLS AND SPECIALTIES

**266—Installation & Maintenance Tools.** Tube expanders, air motors for driving them, buffing tool, polishing wheels and brushes, tube calipers, wrenches, jigs, plug pulling devices and other essential tools for the correct assembly and satisfactory operation of return bend fittings and tubes are pictured and described in 16-page bulletin 451. Includes table of expander sizes as well as chart showing recommended sizes of air motors. Key Co.

**267—Arc Welder.** Heavy duty ac welder for all general welding applications is illustrated and described in 2-page bulletin M88-351. Features and advantages of the unit and regular accessories are listed as are operating data. Specifications included. Miller Electric Mfg. Co.

**268—Tube Expander Control.** Precision expanding of heat transfer equipment tubes is covered in 18-page bulletin C350 on electronic tube expander control. Describes and illustrates various units of the control and its correct application. Gives information on operation together with maintenance and service hints. Franklin Mfg. Co.

**269—Hydraulic Puller.** Bulletin 97A, 8 pages, on hydraulic puller (capacity

17½ ton—weight 10 lb) completely describes how the tool with its "Center Hole" feature adapts itself to all OTC pulling systems now in use. Illustrates methods for installing and removing cylinder sleeves, shafts, gears, wheels and other usages. Owatonna Tool Co.

### VALVES, PIPING AND FITTINGS

**271—Steam, Air Traps.** Data on steam traps and air traps are contained in 12-page condensed catalog. Lists cast semi-steel and forged steel inverted bucket traps, compound steam traps, ball float air traps, Y-type strainers and internal check valves. There are four pages of information on calculation of condensate loads and selection of traps to handle these loads. Parts list also included. Armstrong Machine Works.

**272—Steam, Air, Gasoline Traps.** Catalog 751, 32 pages, illustrates and describes five types of thermostatic steam traps for pressure to 225 lbs; two types of expansion steam traps for pressures to 250 lbs; three types of weight-operated traps for steam, air, gasoline, pressures to 1500 lbs; also three types of steam, air and gas separators. Complete with capacity tables, installation diagrams, as well as a section containing data, charts and formulas for determining proper size trap for specific applications. W. H. Nicholson & Co.

**Bulletins and catalogs reviewed here are yours for the asking. Use card inserted between pages 140 & 141**

**273—Relief Valves.** Bulletin W-2 contains 8 pages of information about cushioned surge relief valves. Features detailed sectional diagrams of the units and gives general and installation arrangements. Parts, materials, and dimensions are tabulated, and valve adjustment, servicing, operation, and other considerations are described and discussed. Golden Anderson Valve Specialty Co.

**274—Packing Units.** Packing units for Chiksan ball-bearing swivel joints are pictured and described in 4-page bulletin. Tables give joint sizes and material, and show proper packing unit for each style. Packing arrangements for the units are shown in sketches. Ordering information included. Chiksan Co.

**275—Rubber-Lined Valves.** Gate and check valves, lined with hard rubber, are illustrated and described in bulletin. Diagrams and cutaways show design and construction features of the different types available. Tables give sizes, dimensions, capacities, etc. Darling Valve & Mfg. Co.

**276—Piping Insulation.** Well illustrated 24-page booklet 37-B discusses the advantages of cellular glass insulation, listing its properties, typical data for cold, intermediate, and hot applications, details for insulating tanks, ducts, removable covers, and tank heads, accessory materials, and prominent users. Tables show sizes and shapes available

*Available with Visible and Audible Alarms and Repeaters at auxiliary points.*

THE Jerguson Truscale Gage reproduces your boiler water, deaerating tank, or other liquid level at remote points with accuracy as close as ½ of 1%. This is made possible by a design which transmits movement changes in a mercury-filled manometer through a specially designed featherlight pointer system. A unique magnetic coupling, with a magnetically energized yoke operating on precision bearings, uses the maximum of coupling force available with a minimum of inertia in the pointer system.

The extreme sensitivity and close accuracy of the Jerguson Truscale Gage gives you *dependable liquid level readings at remote points.* The Truscale Gage has a built-in adjustment for easy calibration for any W.S.P. The dial is illuminated, the scale markings and pointer glow in the dark, and the gage is available with visible and audible alarms.

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24" stainless steel butterfly valve with Cono-Control air diaphragm operator and auxiliary hand wheel control; operation at high temperature.

20" rubber-lined butterfly valve with air cylinder and counterweight; for corrosive vapors at 215°F.

30" butterfly valve for 60 p.s.i. operating pressure; equipped with Janette electric motor operator.

Pipe up to W.S. ROCKWELL Automatic Butterfly VALVES

For air, gases, liquids, semi-solids—corrosive or abrasive—hot or cold—at pressures to 100 p.s.i., Rockwell Butterfly Valves provide controlled flow and quick shut-off that's automatic and trouble-free.

Made in all pipe sizes to 72", any metal or rubber-lined; may also be manually controlled.

Ask to be put on list to receive monthly issue of the Valve News about Rockwell Butterfly and Slide Valves.

W. S. ROCKWELL CO.
230 Eliot St., Fairfield, Conn.

# New bulletins and catalogs

*( Continued from page 161 )*

in pipe insulation, standard blocks, beveled lags, and standard curved segments, and recommended shapes and thicknesses. Pittsburgh Corning Corp.

**277—Steam Traps.** Bulletin T1740 gives 24 pages of information on steam traps. Includes chapters on why use a steam trap, advantages, how to figure sizes, installation and operating suggestions, and how to size condensate return lines. Booklet should be of help to all concerned with steam equipment. Charts and tables include capacities, pipe dimensions, thermo-dynamic properties of saturated steam, along with prices, weights and dimensions. Diagrams show applications, installations, and how the trap works. Yarnall-Waring Co.

**278—Swivel Joints.** Ball-bearing swivel joints and fabricated products for industrial applications are shown and described in 18-page catalog 50D. Includes thorough discussion of turning principle as well as description of packing units. Sizes, working pressures and temperatures, end connections, and lubricating data are given. Chiksan Co.

**279—Steam Traps.** "How Increasing Your Steam Costs Can Save Money" offers helpful information regarding the efficient use of steam. Written in easy-to-read style, the 8-page booklet consists of 16 questions and answers that should benefit those concerned in making or using steam. Sarco Co., Inc.

**280—Non-Return Valves.** Cushioned triple acting non-return valves for steam control in case of damaged boilers or headers are described in 8-page bulletin S1. Said to automatically perform the following functions: cut in boiler when boiler pressure equals header pressure; close to isolate boiler when boiler pressure decreases below header pressure; and close to isolate boiler when header pressure decreases to approximately 8 lbs below boiler pressure. Included are complete technical description, engineering diagrams of three different body and yoke patterns, parts list, and operating and installation instructions. Golden-Anderson Valve Specialty Co.

## HEATING, VENTILATING AND AIR CONDITIONING

**286—Concentrators.** Niagara offers two pieces of literature—bulletins 118 and 119—describing and illustrating the no-frost method of refrigerating spaces. Explains advantages of the system and shows economical benefits. Flow diagrams along with installation photos show the units in operation. Capacities and dimensions included. Niagara Blower Co.

**287—Dehumidifiers.** Method of combining chemical dehumidification with mechanical refrigeration, said to obtain air of extremely low dew point at sub-zero temperatures, is outlined in 4-page bulletin K151. Features of the units are listed and typical installations are shown. Schematic drawing and flow charts show general and specific arrangements of the system. Kathabar Div., Surface Combustion Corp.

**288—Air Conditioner.** Self-contained air conditioner for spot applications is pictured and described in 4-page bulletin. One electrical and three piping connections are all that is required to install the 3, 5, or 7½ ton units, says the booklet. Features, dimensions, and operating and maintenance instructions are included. The Trane Co.

## MISCELLANEOUS

**290—Hydraulic Oils.** Technical bulletin B4 (revised) is a 44-page guidebook for all who are interested in the use of hydraulic oils in industry. Contains fundamental information on hydraulic systems, maintenance, trouble-shooting, and selection of proper fluids. Sun Oil Co.

**291—Lubricator.** Details on general purpose, force feed lubricator are presented in 12-page catalog 94-C. Discusses general construction and operation of the liquid sight feed type unit and gives explanation of various features. Two pages of dimensions and engineering data are contained. Manzel Div., Frontier Industries, Inc.

**Bulletins and catalogs reviewed here are yours for the asking. Use card inserted between pages 140 & 141**

**292—Stainless Steel Handbook.** Complete on-the-job reference data on stainless steels is offered in completely rewritten 120-page cloth-bound volume. It discusses approximately 40 different types of stainless steel and covers each type from standpoints of analyses, fabrication, heat treatment and special conditions of service. Selector table containing about 30 types, list 40 properties. Second group of tables lists the corrosion resistance to the various media. The Allegheny Ludlum Steel Corp.

**293—Automatic Oilers.** Bulletin 4900 was designed to aid in selecting the proper visible, automatic oiler for constant level, gravity, wick, underfeed, multiple and large capacity gravity feed applications. Contains valuable suggestions on how to eliminate waste and dangers of "trust-to-luck" oiling. Installation photos show actual applications. The broadside opens to 17 x 22 making it useful as a wall chart. Trico Fuse Mfg. Co.

**294—Immersion Heaters.** "100 Ways to Apply Electric Heat" gives complete details showing how to use immersion heaters in industrial applications. Drawings and photographs illustrate installations. Offers engineering service for assistance and recommendations. Edwin L. Wiegand Co.

"LIQUIDS WORTH STORING ARE WORTH MEASURING" with a

LIQUIDOMETER Tank Gauge

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Eligible under NPA Regulations 22 and 24.

SAVE TIME • MONEY
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PROVE IT!

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|---|---|---|---|
| • Dirt Proof — Hermetically Sealed? | Yes | | |
| • Extreme Accuracy? | ±1° | | |
| • Packing or Glands to Leak? | No | | |
| • Drop-tight Shut off? | Yes | | |
| • Vapor-stream Energized Super Power Pilot? | Yes | | |
| • Supervision—Maintenance? | None | | |

Write for Stacon Bulletin 50-1600. It contains complete information on the most sensitive, accurate, economical temperature regulator available . . . anywhere.

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No longer is it necessary to close off an area of concrete floor while waiting for newly installed patches to set. Flexrock offers a new plastic repair material which is ready for traffic almost the moment it's put down.

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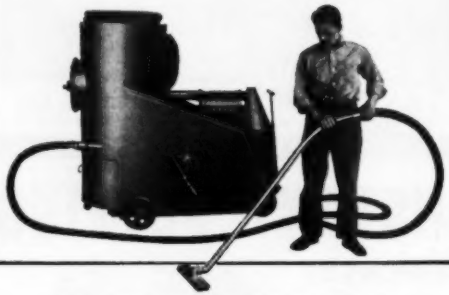
**One installation sells another, as plant after plant finds that Hoffman vacuum cleaning units save labor—salvage material—reduce product defects—eliminate dust hazards. They've proved that they can clean larger areas of walls, floors and overhead surface with Hoffman equipment. Built to provide bigger capacity, higher vacuum and long years of service on the most grueling plant cleaning jobs.**



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**Advanced design and construction features for fast, efficient cleaning, with one-man handling. 1½, 3, 5, and 7½ H.P. models to match your specific cleaning requirements**

**STATIONARY SYSTEMS IN A WIDE RANGE OF SIZES TO FIT YOUR MAINTENANCE OR PRODUCTION OPERATIONS**

**Provides cleaning in several areas at the same time. Sweepers attach cleaning hose to conveniently located inlets (in a permanently piped system). Dust is removed pneumatically to central collectors for easy disposal.**

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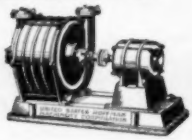
**For agitation of liquids, combustion, mixing—for all air requirements (including the elimination of compressed air). No internal moving parts. Low power consumption. Adopted as standard in steel plants, textile and ice plants requiring 24-hour continuous service. Wide range of pressures, capacities and vacuum, for air or gas. Tell us your requirements.**



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CANADIAN PLANT: CANADIAN HOFFMAN MACHINERY CO. LTD. NEWMARKET, ONT.


# Spot news

*( Continued from page 116 )*

ings—lamp designation, dimensional characteristics, operating characteristics, and starting requirements. The lamp dimensions listed are those necessary for drawing plans for the manufacture of lamp holders, lighting fixtures and the lighting installations.

Copies of the standards may be obtained from the American Standards Association, 70 East 45th Street, New York 17, N. Y. at 25 cents per copy.

## New Handbook Includes 21 Mineral Wool Insulation Specifications

A practical insulation handbook, "Mineral Wool Insulation Specifications and Standards," has just been published by the Industrial Mineral Wool Institute for buyers, engineers, plant superintendents, specification writers and contractors as a guide in properly selecting materials and application practices for government contracts, as well as a basis for specifications within industry itself. Bound in a flexible cover for easy use on design tables and in the field, the handbook includes 21 specifications and standards approved by four government agencies and the American Society for Testing Materials.

Copies of the handbook are available at $3.50 each from the Industrial Mineral Wool Institute, 441 Lexington Avenue, New York 17, N. Y.

## New Five Million Dollar Industrial Belt Plant Now in Operation at Akron

A new $5,000,000 industrial belting plant, said to be the most modern in the world, has been completed and is now in full production, B. F. Goodrich Co. has announced.

The plant will enable the company to meet the demand

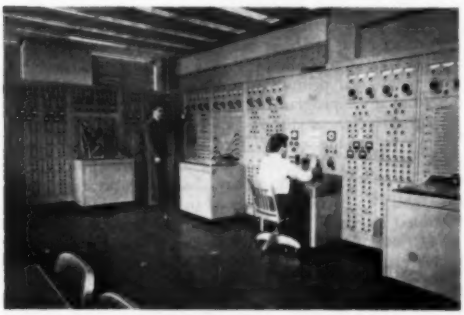
***New rotary press in B. F. Goodrich's $5,000,000 plant will permit continuous production of many types of belting***

for ever larger conveyer belts. They can now produce belting in single rolls weighing up to 35 tons—as large as existing rail and truck facilities can handle.

Among the features of the new plant are a 664,000 lb press for vulcanizing belts, newest equipment for making steel cable conveyer belts, a humidity controlled section for manufacturing V-belts, a long belt-building table specially designed with the latest tension control devices, and a complete materials handling system for speedy delivery of raw materials to the production department. A new $235,000 rotary press permits continuous production of certain types of transmission belting, sheet packing and floor matting.

## New Network Analyzers Will Solve Any Complex Power Distribution Problem

A new system of interconnections between the two a-c network analyzers at the General Electric Co. in Schenectady, has resulted in a 24 generator board of extremely large capacity. The new interconnections are needed to solve many



***New system of interconnections between two a-c network analyzers at G. E. plant in Schenectady makes it possible to solve power companies' complex distribution problems***

complex system problems brought about by the rapid growth of electrical loads and the increased tendency to interconnect power systems.

The network analyzers can be used to obtain simulated picture of the distribution of voltage, current, and real and reactive power in any power network.

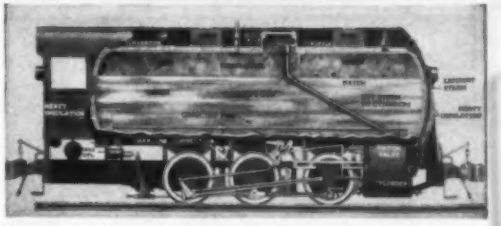
The modernized board is divided into three sections containing approximately 1/8, 3/8, and 1/2 of the units on each board. Any of these sections, or any combination of them, may be used with the other board while the remaining sections are free for separate study.

## Speed Repair of Flood-Damaged Electrical Equipment with Special Repair Facilities

Since the flood waters of the Missouri and Kaw rivers have subsided to leave Kansas City's electrical apparatus visible but wet and mud clogged, the emergency repair depot set up by the Westinghouse Electric Corp. has overhauled and returned to service more than 750 electric motors, some three dozen power transformers representing a total capacity of 18,000 kva, and more than 100 major pieces of electrical switchgear.

Emergency repair facilities were set up in a 30,000 sq

***( Continued on page 166 )***



*Steam is injected through the charging pipe. Energy is stored in the form of heat, in the water. Charging requires from ten to thirty minutes, depending on the steam pressure, and can be done during idle periods.*

If you have steam available in your plant, then a Porter Davenport-Built Fireless Locomotive can save you up to 50% in haulage and switching costs. This is a challenging statement that has been proven in hundreds of important industrial installations.

*Porter Fireless Locomotives are made in all sizes from 10 to 100 tons, either geared or direct drive.*

Particularly valuable is the fireless—smokeless—noiseless feature wherever the locomotive operates indoors, wherever fire or explosion hazards exist and where avoidance of smoke, soot and dust is a MUST. Avoidance of noise is appreciated almost everywhere—a soft exhaust is the only noise when a Porter Fireless is used.

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Available in
STEAM
FIRELESS
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with
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or MECHANICAL
DRIVE

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Established 1866

**WE ANALYZE YOUR NEEDS**

Conditions of service should be given full consideration so that the locomotive may be designed to meet the requirements. Our engineers will gladly study your operating conditions and range of work—and then submit reliable recommendations as to type and size of locomotive. No obligation whatsoever.

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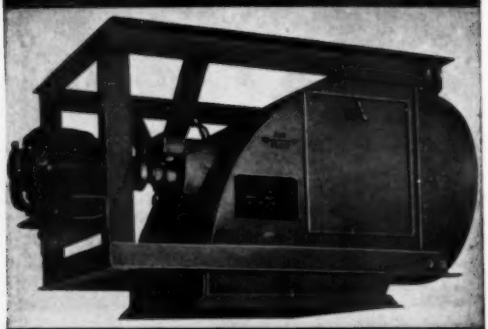
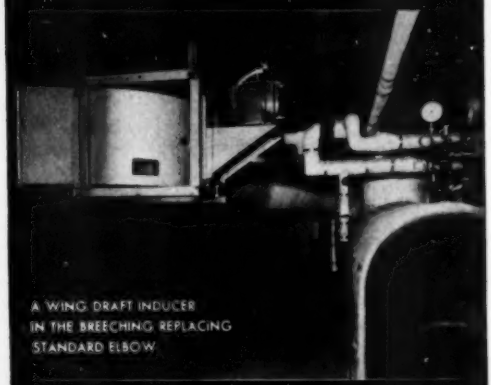


THIS IS A TYPICAL INSTALLATION



A WING DRAFT INDUCER IN THE BREECHING REPLACING STANDARD ELBOW

THIS IS WHAT IT WILL DO

1. Eliminate tall, unsightly and expensive stacks. All that is left is a vent on the discharge.
2. Cut fuel costs. Give higher $CO_2$'s. Less excess air.
3. No smoke.
4. Permit increased capacities.

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139 Vreeland Mills Road
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Please send literature and complete information on the Wing Draft Inducer.

Name.....
Firm.....
Address.....
City..... Zone..... State.....

# Spot news

( Continued from page 165 )

ft area of the company's jet engine plant in Kansas city, Mo. These facilities are used exclusively to speed up industrial rehabilitation of the flood stricken area, a task that may take from six weeks to two months.

C. G. Roush, manager of the Westinghouse Kansas City office, is coordinating the company's emergency repair program for the stricken city. Repair specialists have been brought from Boston, Atlanta, Philadelphia, Chicago, Detroit, Denver, Pittsburgh, Cincinnati, Houston, St. Louis, and other cities to aid the local force of Westinghouse people at the jet engine plant.

## Kit of Maintenance Instructions Is Offered to Plant Engineers

A new plan to help industry get the most productivity from its existing facilities has been announced by the General Electric Co. Called "Productive Maintenance", the plan is designed primarily to assist maintenance engineers in setting up a program to minimize lost production time and forced idleness due to equipment failures. It recommends (1) an adequate staff of trained maintenance men, armed with (2) the tools needed to perform properly the functions of (3) regular, routine checks of operating equipment, and (4) planned outage of this equipment at regular, scheduled intervals. Rebuilding and modernizing machines during time of planned outage is done readily with (5) an adequate stock of mechanical and electrical renewal parts.

To help the maintenance engineer materially, G. E. offers a "Productive Maintenance Kit," which is a file-size package of maintenance aids to guide him in setting up a working program. The kit contains an instruction bulletin, a typical balance sheet for keeping historical data on each machine, planned outage forms, and check-lists for motors, control and other equipment. To further aid maintenance engineers establish Productive Maintenance programs, G-E service engineers, upon request, will assist in making a complete equipment survey to determine existing conditions, future outages, and to guide in setting-up a working spare parts control.

## New Refinery Facilities Increase U. S. Production of Ethylene 12 Per Cent

The world's largest single unit for the manufacturing of ethylene will employ Worthington centrifugal compressors, driven by Worthington steam turbines, and a turbo gas expander to be used for recovery of temperature from product to battery limits. The unit is being built for the Gulf Oil Corp. at Port Arthur, Texas by the Lummus Co. of New York City.

Compressors, driven by a total turbine capacity of over 20,000 hp, will compress hydrocarbon gas mixtures in the manufacture of ethylene—a gas used extensively as a raw material in making chemicals valuable to the national defense. The new multi-million dollar facilities will produce nearly 2.5 billion cu ft yearly, increasing total U. S. production of this highly important chemical component by approximately 12 per cent. Construction has already begun and is scheduled for completion next spring.

A few of the many important products made from ethyl-

ene are: ethyl alcohol, vinylchloride and polyethylene (for plastics), styrene (for synthetic rubber and plastics), ethylene glycol (for permanent type anti-freeze), ethyl chloride and tetraethyl lead (for improving gasoline anti-knock properties), ethanolamine (emulsifying agent), ethylene oxid (chemical intermediate), cellulose acetate (for artificial silk), and acetic acid.

## Large Coal Preparation Plant In Ohio Has 1275 Ton Per Hr Capacity

The Georgetown Preparation Plant at Cadiz, Ohio, reported as largest coal cleaning plant in the commercial bituminous industry, was officially opened a few weeks ago by the Hanna Coal Co. Div. of Pittsburgh Consolidation Coal Co. Costing more than $5 million (exclusive of rail and weighing facilities) and requiring two years to build, it is the latest completed project in Pittsburgh Consolidation's large program of modernization and new development. Under this program the company has made capital expenditures of $80 million during the past 5½ years.

With a capacity of 1,500 tons of raw coal input per hour, the plant will produce, on the average, an hourly output of 1275 tons of clean product. This big scale of operation has made it possible to design for maximum efficiency in the layout of the plant and in the selection of processes and equipment.

Preliminary operations show some unusual results in the quality and uniformity of the product: Coal is upgraded in heat value from a range of 10,000 to 12,000 Btu per lb for raw coal to about 13,000 Btu per lb for the clean product.


ONE MAN and a *Silent Hoist* electric-driven Car Puller can pull and spot cars ... warp barges ... drag pallet or skid loads, logs, quarry stone, heavy equipment ... bend pipe ... open hopper doors ... etc. ... and Cut Your Materials-Handling Costs!

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**Write for Bulletin No. 64A**

*Mfrs. of KRANE KAR Swing-Boom Mobile Cranes ... Heavy-Duty Fork LIFTRUK ... Cranes for Motor Trucks ... Capstans, Gypsies, Single and Double Drum Winches.*

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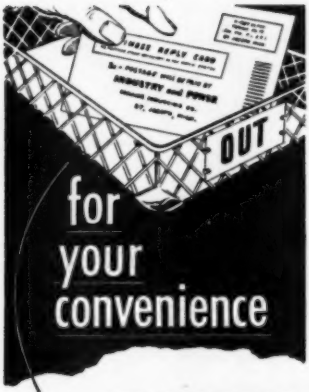
*Ready to give you on-the-job service ...*




**READERS' GUIDE**

See page 134 for classified list of literature offered by advertisers.

You'll find it so convenient to use one of the postcards on page 140 for requesting literature or more information about advertised products. Just list the paragraph key numbers for material you want and drop the card in your OUT basket. Your inquiry will be processed quickly and accurately.

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Packaged all expense-included thrill trips with meals, shows and all the sights of the wonder city.
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Address your correspondence to:

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One Enterprise Model DSQ-6, 16 x 20 Diesel Engine. 797 HP. 327 RPM. Direct connected to Elliott AC Generator 800 Kw 50° C. rise continuous. 2400 volts, 3 phase, 60 cycle, with all necessary switch gear and Maxim steam generating silencer. Used 14,275 hours.

One Enterprise Model DSQ-8, 16 x 20 Diesel Engine. 1075 HP, 327 RPM. Direct connected to Elliott AC Generator 1000 KVA, 800 Kw, 2400 Volt, 3 phase, 60 cycle, with all necessary switch gear and Maxim steam generating silencer. Used 17,423 hours.

One Fairbanks-Morse Model 32 - E - 14 x 17 Diesel Engine. 300 HP, 300 RPM. Direct connected to Generator, type TGZ-6, 250 KVA, 3 phase, 60 cycle, with all necessary switch gear and silencer. Used 27,000 hours.

**NYLEN PRODUCTS COMPANY**
**St. Joseph, Michigan**

## AVAILABLE REPRINTS

**SPECIAL REPRINT**
***of the report on***
**INDUSTRIAL WASTE TREATMENT**

To fill requests we've received for additional copies of the special report on "Industrial Waste Treatment", June 1951 issue, it has been necessary for us to re-order reprinted copies. These copies are still being offered to our readers ***free of charge in quantities of 1 to 5.*** However, it is necessary for us to make a small charge, sufficient only to defray printing costs, for larger quantities. These prices are: 6 to 25 copies—25¢ each; 26 to 50 copies—20¢ each; more than 50 copies—15¢ each. Order directly from Reader Service Department, INDUSTRY AND POWER, 420 Main Street, St. Joseph, Michigan.

We also have copies of the following article reprints which are available to you free of charge:

"Boiler Houses Are Not Necessary Evils", February, 1950

"Caribou Diesel Plant Built In A Hurry", February, 1950

"Correct Plans Consider Future Expansion Too", December, 1950

"Filters . . . What They Are, How and Why They Are Applied", February, 1951

"Grievances Can Be Avoided", April, 1950

"Harbor Plant Pioneers in Pneumatic Build-Up Refractory", December, 1950

"How To Select the Correct Steam Trap", January, 1950

"How To Select Corrugated Expansion Joints" June, 1950

"Know Your Fuses", March, 1951

"Low Cost Auxiliary Power From Turbine Drives", April, 1950

"Proper Water Tower Means Water Conservation", March and April, 1951

"Qualifications of an Industrial Supervisor", June, 1949

"Select Correct Batteries for Starting Diesels", November, 1949

"Signode Plant 'Pressurized' to Eliminate Cold Drafts", November, 1949

"Simplify Determinations of Pipeline Pressure Losses", November, 1949

"Steam, Air, and Power for 3 New Ford Assembly Plants", May, 1949

"Streamlined Steam Plant Insulation", May, 1951

"Supervisor's Personal Check-Up Chart", November, 1949

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"Television . . . The Eyes of Industrial Control', December, 1950

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1—Edge Moor 1000 H.P. longitudinal drum water tube boiler 200# pressure, complete with all regular fittings. Foster Wheeler 125° Internal Superheater. Last operated in 1949. Last inspected in April, 1950, and approved for operation under Penna. State Laws for Pressure vessels. American Engineering Co. Type AA-6 11 retort Taylor Mechanical Stoker. American Blower Corp. 7" x 7" type A vertical slide valve Steam Engine. B. F. Sturtevant Co. Type M fuel economizer and 66" Multivane forced draft fan also size 10 design 3 multivane induced draft fan. Complete details on request. To be sold as is, where is.

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2 DIESEL ENGINES—Both are Fairbanks-Morse Company diesel engines equipped with alternators and exciters for generating electric current. One is 2 cylinder style VA-100 HP - 257 RPM with Type D alternator - 75 KVA. The other is one cylinder same style but 50 HP - 40 KVA. Fuel systems of both engines have been modernized. Both are 230 volt, 3 phase, 60 cycles. Further details and prices on application.

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**Arkansas City, Kans.**

**BLOW-OFF VALVES**

Used, but in ***good*** condition.

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3 — 2½" B & W 200 Lb. Blow-Off Angle Valves
12 — 1½" B & W 200 Lb. Blow-Off Angle Valves

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North Chicago, Illinois

Complete 2500 KVA - 600 volt G.E. Turbo Generating Unit 4 stage condensing. Also Foster Wheeler 2 cell draft tower (fan cooled).

**Maverick Mills East Boston, Mass.**

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BLAW-KNOX DIVISION
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1 Rigid one-piece construction—easy to install.
2 Maximum open area for light and air.
3 Easy to paint—all surfaces accessible.
4 Non-slip Twisted Cross-Bar.
5 Self-cleaning—no sharp corners to clog.

*Blaw-Knox Grating Has Them All!*

WRITE FOR BULLETIN 2365

JOB PROVED
TRICO "Powder-Packed" FUSES
AND "Kliplok" CLAMPS

- REDUCE FUSE BLOWS
- CONSERVE POWER
- LOWER FUSE COSTS
- GIVE 3 TIMES THE SERVICE

"KLIPLOK" CLAMPS

"Lock Like A Vise" . . positive insurance against unnecessary shutdowns . . lost production . . doubling-up fuse links. Quickly pay for themselves.

TRICO FUSES

The ONLY renewable fuse with a "Powder-Packed" element, CUSTOM-BUILT to stop needless fuse blows and vicious tampering. Save current . . give SAFE time-lag. WRITE FOR BOOKLET 206-A.

"Kliploks" can be used on ALL fuse clips. Especially recommended for use with Thermal or Dual-element fuses because of their design and long time-lag characteristics. WRITE FOR BULLETIN NO. 7.

TRICO FUSE MFG. CO. Milwaukee, Wis.

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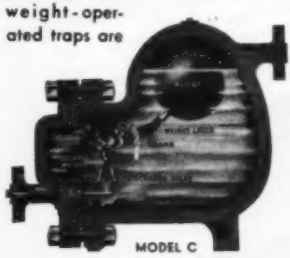
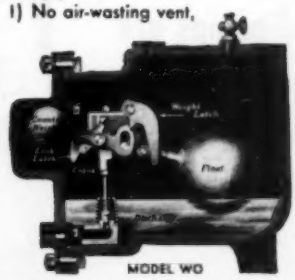


MODEL C

*for steam and air pressures to 1500 lbs.*



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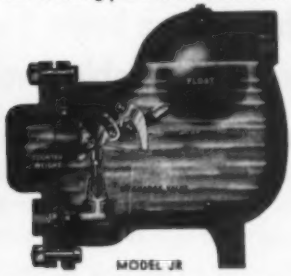

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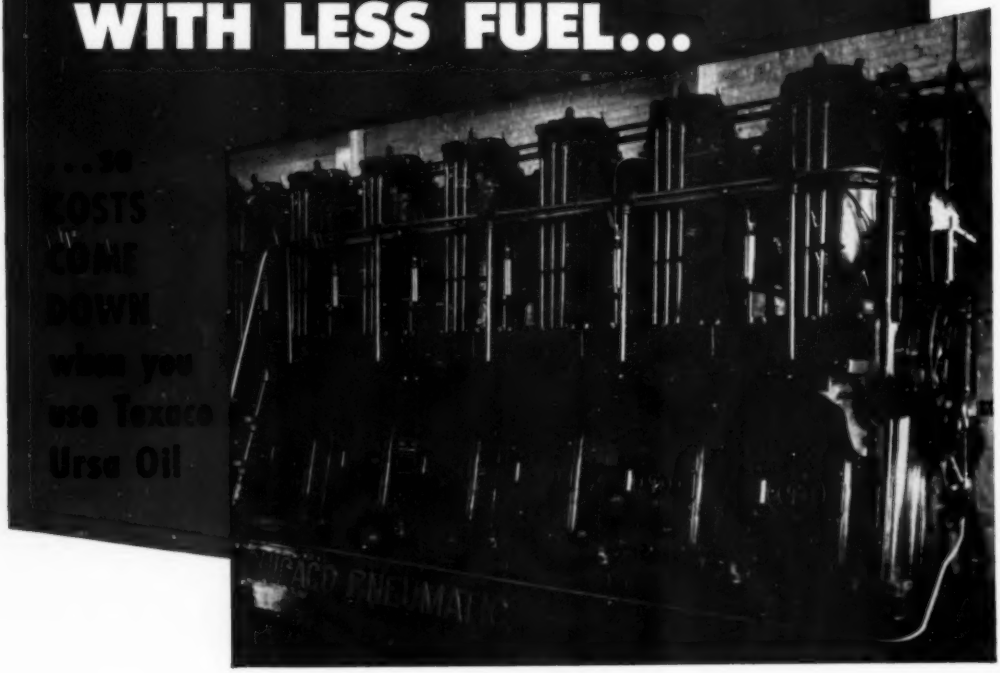


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